AddTex

Advancing industrial digital and green innovations in the advanced textile industry through innovation in learning and training

D2.1 Gap Analysis Report including National & EU Reports

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1. Executive summary

The ADDTEX projects main objective is to support the resilience and sustainable GREEN, DIGITAL & SMART transition and advancement in the textile sector through innovative learning and training. The partners representing Czech, Germany, Greece, Italy, Ireland, Portugal, Romania, Slovenia, Spain and Sweden have researched the innovations, challenges and opportunities critical to the sector; and established that strategical engagement between industry representatives and higher education (HEI) and vocational education and training (VET) providers, is an assertive way to achieve the project's goal.

272 Textiles companies, 47 VET and 55 HEI participated in this phase of the project in different collaborative sessions (Meetup: 87 companies, 17 VET, 18 HEI; Field research: 94 companies, 15 VET, 18 HEI; Living Lab: 91 companies, 15 VET, 19 HEI) . Through this research and gap analysis a series of recommendations have been made to assist in areas specific to the green, digital and smart transitions.
Advanced textile materials are a thriving sub-sector in the textile and clothing ecosystem across Europe, based on high added value and differentiation as unique selling proposition. Innovation in this field is key in the resilience building of the EU textile sector and in ensuring its competitiveness, particularly in volatile, uncertain, complex and ambiguous (VUCA) environments, such as were presented through the COVID-19 pandemic.

The project aims to strengthen and stimulate a sense of initiative and entrepreneurial attitudes, mindsets and skills in learners, educational staff and skilled workers, in line with the Green Deal and Entrepreneurship Competence Framework. The strength and expertise of established and developing industry clusters will continue to build competencies, support the textile sector growth and present opportunities for impact driven, sector-specific research.

The research that focused on gap analysis began in 2022. Desk-based research was used to identify innovations, challenges and opportunities facing the textile industry and HEI and VET providers. Following this, field research was introduced and through the successful engagement of 94 industry partners. Meet-ups, workshops and living labs followed, providing a platform to share key insights and gather information relevant to the sectoral challenges. The range of methodologies employed, successfully unearthed complex challenges facing the textile industry in relation to sustainable practices and circularity, smart systems and digital tools and technologies innovating the sector.
In order to bridge the gaps identified, a combined and holistic approach is required, fostering the digital and green transition from the early-stage entry of graduates and skilled workers into the industry, through to supporting established teams seeking up-skilling, ensuring that they remain agile and resilient in the sector.
Facilitation of knowledge transfer and exchange throughout the industry ecosystem is vital to sustainable growth and smooth transition. The ADDTEX project will support continued cluster activities, engaging academics and researchers in collaborative research to foster new, innovative and multidisciplinary approaches to teaching and learning. Knowledge transfer and skill exchange will be supported through educational tools and Massive Open Online Courses (MOOCs) that

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engage existing teams through accessible platforms that connect graduates and skilled workers with industry and encourage co-creation between the academic and industrial sectors.

The gap analysis work package brings together the findings of the ADDTEX partners, 47 VET providers, 55 HEI and 272 Textile companies.
Companies that participated in the research provided insights into the challenges and recognised opportunities relating Green, Digital & Smart technologies, identifying areas in which innovations and impact can be achieved through learning and training. These include:

GREEN

- Waste mitigation, management and recycling
- Energy and resource consumption
- Sustainable fibre innovations and technological advancements in fibre processing and recycling
- LCA, Life Cycle Analysis, assessment and traceability across all critical phases and areas of operations
- Innovations and ambitious projects linked to dying, finishing & water management

DIGITAL

- Technologies linked to streamlining production
- Smart sensor technologies for data acquisition
- Tracking and authentication methods
- Database management and cyber security
- Design Tools and software evolution

SMART

- Smart authentication methods & Radio Frequency Identification RFID technologies
- Complex composites and integrated electronics
- Innovations linked smart & intelligent textiles
- Smart sorting systems and Ai
- B2B communications and Marketing using VR & AR

The ADDTEX partners will commence planning and begin to implement work package 3 (WP3) which will take the results of this report and uses the findings to inform and expand a suite of industry-specific resources and online training and learning tools and MOOCs to address the gaps identified through the research and support the sector and its wider ecosystem.

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CZECH

SHRNUTÍ

Hlavním cílem projektu ADDTEX je podpora udržitelného rozvoje v textilním sektoru v oblasti ZELENÉ, DIGITÁLNÍ & SMART transformace prostřednictvím inovativního učení a školení. Partneři zastupující Česko, Německo, Řecko, Itálii, Irsko, Portugalsko, Rumunsko, Slovinsko, Španělsko a Švédsko zkoumali inovace, výzvy a příležitosti, které jsou pro tento sektor zásadní; a stanovili, že rozhodujícím způsobem, jak dosáhnout cíle projektu, je strategické zapojení zástupců průmyslu a poskytovatelů vysokoškolského vzdělávání (HEI) a odborného vzdělávání a přípravy (VET).

272 textilních společností, 47 VET a 55 VET se zúčastnilo této fáze projektu na různých společných setkáních (Meetup: 87 společností, 17 VET, 18 VET; terénní výzkum: 94 společností, 15 VET, 18 VET; Living Lab: 91 společností, 15 VET, 19 VŠ). Prostřednictvím tohoto výzkumu a gap analýzy byla vytvořena řada doporučení, která mají pomoci v oblastech specifických pro oblasti zelené, digitální a inteligentní transformace.
Pokročilé textilní materiály jsou prosperujícím pododvětvím v textilním a oděvním ekosystému v celé Evropě, založeném na vysoké přidané hodnotě a diferenciaci jakožto jedinečné prodejní nabídce. Inovace v této oblasti jsou klíčové pro budování odolnosti textilního odvětví EU a pro zajištění jeho konkurenceschopnosti, zejména v nestálých, nejistých, složitých a nejednoznačných (VUCA) prostředích, jaká byla prezentována během pandemie COVID-19.

Cílem projektu je podpořit a posílit podnikatelské chování, myšlení a dovednosti u studentů, pedagogických pracovníků a kvalifikovaných pracovníků v souladu se Zelenou dohodou a Evropským rámcem klíčové kompetence k podnikavosti. Síla a odbornost zavedených a rozvíjejících se průmyslových klastrů bude i nadále budovat kompetence, podporovat růst textilního odvětví a představovat příležitosti pro výzkum zaměřený na konkrétní odvětví.

Výzkum, který se zaměřil na analýzu tržních mezer (gap analýza), začal v roce 2022. K identifikaci inovací, výzev a příležitostí, kterým čelí textilní průmysl, poskytovatelé vysokých škol a poskytovatelé odborného vzdělávání a přípravy, byl použit sekundární výzkum. Díky zapojení 94 průmyslových partnerů mohl být proveden i terénní výzkum. Následovala setkání, workshopy a živé laboratoře (living labs), které poskytly platformu pro sdílení klíčových poznatků a shromažďování informací relevantních pro sektorové výzvy. Řada použitých metodologií úspěšně odhalila složité výzvy, kterým textilní průmysl čelí ve vztahu k udržitelným postupům a cirkulární ekonomice, inteligentním systémům a digitálním nástrojům a technologiím inovujícím toto odvětví.

Abychom překonali zjištěné mezery, je nutný kombinovaný a holistický přístup, který bude podporovat digitální a zelené transformace, od raného vstupu absolventů a kvalifikovaných pracovníků do průmyslu, až po podporu zavedených týmů, které hledají zvyšování kvalifikace a zajišťují, že zůstanou v oboru agilní a odolní.
Usnadnění přenosu znalostí a výměny v rámci celého průmyslového ekosystému je zásadní pro udržitelný růst a hladkou transformaci. Projekt ADDTEX podpoří pokračující klastrové aktivity, zapojí akademické a výzkumné pracovníky do společného výzkumu s cílem podpořit nové, inovativní a multidisciplinární přístupy k výuce a učení. Předávání znalostí a výměna dovedností bude podporována prostřednictvím vzdělávacích nástrojů a hromadných otevřených online kurzů (MOOC), které zapojí stávající týmy prostřednictvím dostupných platforem a propojí absolventy a

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kvalifikované pracovníky s průmyslem s cílem podpořit spolupráci mezi akademickým a průmyslovým sektorem.

Pracovní balíček analýzy tržních mezer spojuje zjištění partnerů projektu ADDTEX, 47 poskytovatelů odborného vzdělávání a přípravy, 55 vysokých škol a 272 textilních společností.
Společnosti, které se zúčastnily výzkumu, poskytly vhled do výzev a identifikovaných příležitostí souvisejících se zelenými, digitálními a inteligentními technologiemi a identifikovaly oblasti, ve kterých lze inovací a dopadu dosáhnout prostřednictvím učení a školení. Tyto zahrnují:

ZELENÉ technologie

- Snižování množství odpadu, řízení a recyklace
- Spotřeba energie a zdrojů
- Udržitelné inovace vláken a technologický pokrok ve zpracování a recyklaci vláken
- Analýza životního cyklu (Life Cycle Analysis), hodnocení a sledovatelnost ve všech kritických fázích a oblastech provozu
- Inovace a ambiciózní projekty spojené s barvením textilií, finálními úpravami a hospodařením s vodou

DIGITÁLNÍ technologie

- Technologie spojené se zefektivněním výroby
- Technologie inteligentních senzorů pro sběr dat
- Metody sledování a ověřování
- Správa databází a kybernetická bezpečnost
- Designové nástroje a vývoj softwaru

CHYTRÉ technologie

- Inteligentní autentizační metody a technologie RFID pro radiofrekvenční identifikaci
- Komplexní kompozity a integrovaná elektronika
- Chytré a inteligentní textilie propojené s inovacemi
- Inteligentní třídicí systémy a umělá inteligence
- B2B komunikace a marketing pomocí VR (virtuální realita) a AR (augmentovaná realita)

Partneři projektu ADDTEX zahájí plánování a implementaci pracovního balíčku 3 (WP3), který převezme výsledky této zprávy a použije zjištění k informování a rozšíření sady zdrojů specifických pro odvětví a online školicích a výukových nástrojů a MOOC k řešení tržní mezery zjištěné prostřednictvím výzkumu a podporují toto odvětví a jeho širší ekosystém.

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GERMAN

ZUSAMMENFASSUNG

Das Hauptziel des ADDTEX-Projekts ist die Unterstützung der Widerstandsfähigkeit und des nachhaltigen GRÜNEN, DIGITALEN und SMARTEN Übergangs und Fortschritts im Textilsektor durch innovatives Lernen und Training. Die tschechischen, deutschen, griechischen, italienischen, irischen, portugiesischen, rumänischen, slowenischen, spanischen und schwedischen Partner haben die Innovationen, Herausforderungen und Möglichkeiten, die für den Sektor entscheidend sind, untersucht und festgestellt, dass ein strategisches Engagement zwischen Vertretern der Industrie und Vertretern der Hochschulen sowie Berufsbildungseinrichtungen ein wirksamer Weg ist, um das Projektziel zu erreichen.

272 Textilunternehmen, 47 Berufsbildungseinrichtungen und 55 Hochschulen nahmen in dieser Phase des Projektes an verschiedenen gemeinsamen Sitzungen teil. Meetup (Information über das Projekt): 87 Unternehmen, 17 VET (Berufsausbildundgseinrichtungen) 18 HEI (Hochschuleinrichtungen); Feldforschung: 94 Unternehmen, 15 VET, 18 HEI; Living Lab (Workshops oder ähnliches): 91 Unternehmen, VET, 19 HEI. Auf der Grundlage dieser Forschung und Lückenanalyse wurde eine Reihe von Empfehlungen ausgesprochen, um in Bereichen zu helfen, die für den grünen, digitalen und intelligenten Übergang spezifisch sind.

Technische Textilien sind ein florierender Teilsektor im Textil- und Bekleidungsökosystem in ganz Europa, der auf einem hohen Mehrwert und der Differenzierung als Alleinstellungsmerkmal beruht. Innovationen in diesem Bereich sind der Schlüssel zur Stärkung der Widerstandsfähigkeit des EU-Textilsektors und zur Sicherstellung seiner Wettbewerbsfähigkeit, insbesondere in unbeständigen, unsicheren, komplexen und mehrdeutigen Umgebungen (VUCA - schwierige Rahmenbedingungen der Unternehmensführung), wie sie durch die COVID-19-Pandemie entstanden sind.

Das Projekt zielt darauf ab, den Sinn für Eigeninitiative und unternehmerische Einstellungen, Denkweisen und Fähigkeiten bei Lernenden, Bildungspersonal und Facharbeitern in Übereinstimmung mit dem Kompetenzrahmen des Green Deal und Unternehmertum zu stärken und zu fördern. Die Stärke und das Fachwissen etablierter und sich entwickelnder Industriecluster werden weiterhin Kompetenzen aufbauen, das Wachstum des Textilsektors unterstützen und Möglichkeiten für eine wirkungsorientierte, sektorspezifische Forschung bieten.

Die Forschung, die sich auf die Lückenanalyse konzentrierte, begann im Jahr 2022. Anhand von Recherchen am Schreibtisch wurden Innovationen, Herausforderungen und Chancen für die Textilindustrie sowie für Hochschul- und Berufsausbildungsanbieter ermittelt. Im Anschluss darauf erfolgte die Feldforschung unter erfolgreicher Einbindung von 94 Industriepartnern. Es folgten Meetings, Workshops und Living Labs, die eine Plattform für den Austausch von wichtigen Erkenntnissen und die Sammlung von Informationen über die Herausforderungen des Sektors boten. Das Spektrum der angewandten Methoden verdeutlichte die Komplexität der Herausforderungen für die Textilindustrie, um den Sektor in Bezug auf nachhaltige Praktiken und Kreislaufwirtschaft, intelligente Systeme und digitale Werkzeuge und Technologien zu erneuern.

Um die festgestellten Lücken zu schließen, ist ein kombinierter und ganzheitlicher Ansatz erforderlich, der den digitalen und umweltfreundlichen Wandel vom frühen Eintritt von Hochschulabsolventen und Fachkräften in die Branche bis hin zur Unterstützung etablierter Teams, die sich weiterbilden wollen, fördert und sicherstellt, dass sie in der Branche agil und widerstandsfähig bleiben.

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Die Erleichterung des Wissenstransfers und -austauschs im gesamten Ökosystem der Branche ist für ein nachhaltiges Wachstum und einen reibungslosen Übergang von entscheidender Bedeutung. Das ADDTEX-Projekt wird die Fortsetzung der Clusteraktivitäten unterstützen und Akademiker und Forscher in die gemeinsame Forschung einbinden, um neue, innovative und multidisziplinäre Ansätze für das Lehren und Lernen zu fördern. Der Wissenstransfer und der Austausch von Fertigkeiten werden durch Bildungsinstrumente und moderne Videokurse (sogenannte MOOCs) unterstützt, die bestehende Teams durch zugängliche Plattformen einbinden, die Hochschulabsolventen und Fachkräfte mit der Industrie verbinden und die Zusammenarbeit zwischen dem akademischen und industriellen Sektor fördern.

Das Arbeitspaket zur Analyse der Wissenslücken (gap-analysis) fasst die Ergebnisse der ADDTEX-Partner, 47 Berufsbildungsanbieter, 55 Hochschulen und 272 Textilunternehmen zusammen.

Die Unternehmen, die an der Studie teilgenommen haben, gaben Einblicke in die Herausforderungen und erkannten Chancen im Zusammenhang mit grünen, digitalen und intelligenten Technologien und zeigten Bereiche auf, in denen Innovationen und Auswirkungen durch Lernen und Ausbildung erreicht werden können. Dazu gehören:

GRÜN

- Abfallvermeidung, -management und -recycling
- Energie- und Ressourcenverbrauch
- Nachhaltige Faserinnovationen und technologische Fortschritte bei der Faserverarbeitung und beim Recycling
- LCA, Lebenszyklusanalyse, Bewertung und Rückverfolgbarkeit in allen kritischen Phasen und Bereichen der Geschäftstätigkeit
- Innovationen und ehrgeizige Projekte im Zusammenhang mit Färbung, Veredlung und Wassermanagement

DIGITAL

- Technologien zur Rationalisierung der Produktion
- Intelligente Sensortechnologien für die Datenerfassung
- Verfolgungs- und Authentifizierungsmethoden
- Datenbankmanagement und Cybersicherheit
- Design Tools und Softwareentwicklung

SMART

- Intelligente Authentifizierungsmethoden und RFID-Technologien (Radio Frequency Identification)
- Komplexe Verbundwerkstoffe und integrierte Elektronik
- Innovationen im Zusammenhang mit smarten und intelligenten Textilien
- Intelligente Sortiersysteme und KI (Künstliche Intelligenz)
- B2B-Kommunikation und Marketing mit VR (Virtual Reality) und AR (Augmented Reality)

Die ADDTEX-Partner werden mit der Planung und Umsetzung des Arbeitspakets 3 (WP3) beginnen, das auf der Grundlage der Ergebnisse dieses Berichts eine Reihe von branchenspezifischen Ressourcen, Online-Schulungs- und -Lerntools sowie moderne Videokurse (MOOCs) entwickeln und ausbauen wird, um die im Rahmen der Forschung ermittelten Lücken zu schließen und den Sektor und sein weiteres Ökosystem zu unterstützen.

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GREEK

Περίληψη

Ο κύριος στόχος του έργου ADDTEX είναι να υποστηρίξει την ανθεκτικότητα και τη βιώσιμη ΠΡΑΣΙΝΗ, ΨΗΦΙΑΚΗ και ΕΞΥΠΝΗ μετάβαση και την πρόοδο στον τομέα της κλωστοϋφαντουργίας μέσω της καινοτόμου μάθησης και κατάρτισης. Οι εταίροι που εκπροσωπούν την Τσεχία, τη Γερμανία, την Ελλάδα, την Ιταλία, την Ιρλανδία, την Πορτογαλία, τη Ρουμανία, τη Σλοβενία, την Ισπανία και τη Σουηδία διερεύνησαν τις καινοτομίες, τις προκλήσεις και τις ευκαιρίες που είναι κρίσιμες για τον τομέα και διαπίστωσαν ότι η στρατηγική δέσμευση μεταξύ εκπροσώπων του κλάδου και παρόχων τριτοβάθμιας εκπαίδευσης (ΑΕΙ) και επαγγελματικής εκπαίδευσης και κατάρτισης (ΕΕΚ), είναι ένας δυναμικός τρόπος για την επίτευξη του στόχου του έργου.

272 εταιρείες κλωστοϋφαντουργίας, 47 πάροχοι ΕΕΚ και 55 ανώτατα εκπαιδευτικά ιδρύματα (ΑΕΙ) συμμετείχαν σε αυτή τη φάση του έργου σε διαφορετικές συναντήσεις συνεργασίας (συνάντηση γνωριμίας: 87 εταιρείες, 17 πάροχοι ΕΕΚ, 18 ΑΕΙ· έρευνα πεδίου: 94 εταιρείες, 15 πάροχοι ΕΕΚ, 18 ΑΕΙ · Living Labs: 91 εταιρείες, 15 πάροχοι ΕΕΚ, 19 ΑΕΙ). Μέσω αυτής της έρευνας και της ανάλυσης έχουν γίνει μια σειρά από συστάσεις για να βοηθηθούν σε τομείς που αφορούν την πράσινη, την ψηφιακή και την έξυπνη μετάβαση.
Τα προηγμένα κλωστοϋφαντουργικά υλικά είναι ένας ακμάζων υποτομέας του οικοσυστήματος της κλωστοϋφαντουργίας και ένδυσης σε όλη την Ευρώπη, που βασίζεται στην υψηλή προστιθέμενη αξία και τη διαφοροποίηση ως μοναδική πρόταση πώλησης. Η καινοτομία σε αυτόν τον τομέα είναι καίριας σημασίας για την οικοδόμηση της ανθεκτικότητας του κλωστοϋφαντουργικού τομέα της ΕΕ και για τη διασφάλιση της ανταγωνιστικότητάς του, ιδιαίτερα σε ασταθή, αβέβαια, περίπλοκα και διφορούμενα περιβάλλοντα (VUCA), όπως αυτά εμφανίστηκαν κατά τη διάρκεια της πανδημίας COVID-19.

Το έργο στοχεύει να ενισχύσει και να τονώσει το αίσθημα πρωτοβουλίας και επιχειρηματικού τρόπου σκέψης, νοοτροπιών και δεξιοτήτων στους μαθητές, στο εκπαιδευτικό προσωπικό και στους ειδικευμένους εργαζόμενους, σύμφωνα με την Πράσινη Συμφωνία και το Πλαίσιο Ικανοτήτων Επιχειρηματικότητας. Η ισχύς και η τεχνογνωσία των υφισταμένων και αναπτυσσόμενων συστάδων (clusters) βιομηχανιών θα συνεχίσουν να δημιουργούν ικανότητες, να υποστηρίζουν την ανάπτυξη του κλάδου της κλωστοϋφαντουργίας και να παρουσιάζουν ευκαιρίες για έρευνα με γνώμονα τον αντίκτυπο στον συγκεκριμένο τομέα.

Η έρευνα που επικεντρώθηκε στην ανάλυση του χάσματος ξεκίνησε το 2022. Η βιβλιογραφική έρευνα χρησιμοποιήθηκε για τον εντοπισμό καινοτομιών, προκλήσεων και ευκαιριών που αντιμετωπίζει η κλωστοϋφαντουργία, οι πάροχοι ΕΕΚ και τα ΑΕΙ. Στη συνέχεια ενσωματώθηκε η έρευνα πεδίου με τη συμμετοχή 94 επιχειρήσεων. Ακολούθησαν συναντήσεις και εργαστήρια, παρέχοντας μια πλατφόρμα για την ανταλλαγή βασικών γνώσεων και τη συλλογή πληροφοριών σχετικών με τις προκλήσεις στον τομέα. Το φάσμα των μεθοδολογιών που χρησιμοποιήθηκαν, αποκάλυψε με επιτυχία σύνθετες προκλήσεις που αντιμετωπίζει η κλωστοϋφαντουργία σε σχέση με τις βιώσιμες πρακτικές και την κυκλικότητα, τα έξυπνα συστήματα και τα ψηφιακά εργαλεία και τεχνολογίες που αφορούν καινοτομίες στον κλάδο.

Προκειμένου να γεφυρωθούν τα κενά που εντοπίστηκαν, απαιτείται μια συνδυασμένη και ολιστική προσέγγιση, ενισχύοντας την ψηφιακή και πράσινη μετάβαση ήδη από την πρώτη είσοδο αποφοίτων και ειδικευμένων εργαζομένων στη βιομηχανία, έως την υποστήριξη ήδη υφισταμένων ομάδων που αναζητούν αναβάθμιση δεξιοτήτων, διασφαλίζοντας ότι παραμένουν ευέλικτοι και ανθεκτικοί στον τομέα.
Η διευκόλυνση της μεταφοράς και ανταλλαγής γνώσεων σε όλο το οικοσύστημα της βιομηχανίας είναι ζωτικής σημασίας για τη βιώσιμη ανάπτυξη και την ομαλή μετάβαση. Το έργο ADDTEX θα

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υποστηρίξει συνεχιζόμενες δραστηριότητες, εμπλέκοντας ακαδημαϊκούς και ερευνητές σε συλλογική έρευνα για την προώθηση νέων, καινοτόμων και διεπιστημονικών προσεγγίσεων στη διδασκαλία και τη μάθηση. Η μεταφορά γνώσης και η ανταλλαγή δεξιοτήτων θα υποστηριχθούν μέσω εκπαιδευτικών εργαλείων και Μαζικών Ανοιχτών Διαδικτυακών Μαθημάτων (MOOCs) που εμπλέκουν υπάρχουσες ομάδες μέσω προσβάσιμων πλατφορμών που συνδέουν πτυχιούχους και ειδικευμένους εργαζόμενους με τη βιομηχανία και ενθαρρύνουν τη συνδημιουργία μεταξύ του ακαδημαϊκού και του βιομηχανικού τομέα.

Το πακέτο εργασίας ανάλυσης του χάσματος συγκεντρώνει τα ευρήματα των εταίρων του ADDTEX, 47 παρόχων ΕΕΚ, 55 ΑΕΙ και 272 εταιρειών κλωστοϋφαντουργίας.
Οι εταιρείες που συμμετείχαν στην έρευνα παρείχαν πληροφορίες για τις προκλήσεις και τις αναγνωρισμένες ευκαιρίες που σχετίζονται με τις Πράσινες, Ψηφιακές & Έξυπνες τεχνολογίες, εντοπίζοντας τομείς στους οποίους μπορούν να επιτευχθούν καινοτομίες και να υπάρξει αντίκτυπος μέσω της μάθησης και της κατάρτισης. Αυτοί περιλαμβάνουν:

ΠΡΑΣΙΝΗ ΜΕΤΑΒΑΣΗ

- Μετριασμός, διαχείριση και ανακύκλωση απορριμμάτων
- Κατανάλωση ενέργειας και πόρων
- Βιώσιμες καινοτομίες και τεχνολογικές εξελίξεις στην επεξεργασία και ανακύκλωση ινών
- Ανάλυση Κύκλου Ζωής, αξιολόγηση και ιχνηλασιμότητα σε όλες τις κρίσιμες φάσεις και τομείς λειτουργίας
- Καινοτομίες και φιλόδοξα έργα που συνδέονται με την βαφή, την τελική επεξεργασία και τη διαχείριση του νερού

ΨΗΦΙΑΚΗ ΜΕΤΑΒΑΣΗ

- Τεχνολογίες που συνδέονται με τον εξορθολογισμό της παραγωγής
- Τεχνολογίες έξυπνων αισθητήρων για την συλλογή δεδομένων
- Μέθοδοι παρακολούθησης και ελέγχου ταυτότητας
- Διαχείριση βάσεων δεδομένων και ασφάλεια στον κυβερνοχώρο
- Εργαλεία σχεδίασης και εξέλιξη λογισμικού

ΕΞΥΠΝΗ ΜΕΤΑΒΑΣΗ

- Έξυπνες μέθοδοι ελέγχου ταυτότητας & Τεχνολογίες RFID αναγνώρισης ραδιοσυχνοτήτων
- Σύνθετα υλικά και ενσωματωμένα ηλεκτρονικά
- Καινοτομίες που συνδέονται με έξυπνα και ευφυή υφάσματα
- Έξυπνα συστήματα διαλογής και τεχνητή νοημοσύνη (AI)
- Επικοινωνίες B2B και Μάρκετινγκ με χρήση εικονικής (VR) & επαυξημένης πραγματικότητας (AR).

Οι εταίροι του ADDTEX θα ξεκινήσουν τον σχεδιασμό και θα αρχίσουν να υλοποιούν το πακέτο εργασίας 3 (WP3), το οποίο θα πάρει τα αποτελέσματα αυτής της έκθεσης και θα χρησιμοποιήσει τα ευρήματα για να ενημερώσει και να επεκτείνει μια σειρά από εξειδικευμένους πόρους του κλάδου, διαδικτυακά εργαλεία κατάρτισης και μάθησης και MOOC για την γεφύρωση του χάσματος που εντοπίστηκε μέσω της έρευνας και τη στήριξη του κλάδου και του ευρύτερου οικοσυστήματός του.

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ITALIAN

RIEPILOGO GENERALE

Il progetto ADDTEX ha come obiettivo principale quello di sostenere la resilienza e le transizioni riguardanti le tecnologie VERDI, DIGITALI E INTELLIGENTI nel settore tessile attraverso modalità innovative di apprendimento e di formazione.
I partner, che rappresentano la Repubblica Ceca, la Germania, la Grecia, l'Italia, l'Irlanda, il Portogallo, la Romania, la Slovenia, la Spagna e la Svezia, hanno analizzato le innovazioni, le sfide e le più grandi opportunità per il settore tessile, stabilendo che un modo efficace per raggiungere l'obiettivo del progetto sia quello di coinvolgere in maniera strategica i rappresentanti del mondo dell'industria, delle università e centri di alta formazione (HEI) e degli enti di istruzione e formazione tecnico-professionale (VET).

In questa fase del progetto hanno partecipato 272 aziende tessili, 47 VET e 55 HEI a diverse sessioni di collaborazione (*Meetup*: 87 aziende, 17 VET, 18 HEI*; Ricerca sul campo*: 94 aziende, 15 VET, 18 HEI; *Living Lab*: 91 aziende, 15 VET, 19 HEI). Attraverso questa ricerca e questi incontri sono state individuate una serie di indicazioni e raccomandazioni per favorire la transizioni verde, quella digitale e quella intelligente in determinate aree dell'industria tessile.
In Europa i materiali tessili avanzati sono un importante sotto-settore in crescita nell'ecosistema del tessile e dell'abbigliamento, basato su un alto valore aggiunto e sulla differenziazione come *unique selling proposition* [1]. Per questo l'innovazione in questo campo è fondamentale per lo sviluppo della resilienza del settore tessile dell'Unione Europea e per garantirne la competitività, in particolare in contesti volatili, incerti, complessi e ambigui (VUCA), come quelli che si sono presentati con la pandemia COVID-19.

Pertanto il progetto si propone di rafforzare e stimolare il senso di iniziativa, le attitudini, le mentalità e le competenze imprenditoriali negli studenti, nel personale educativo e nei lavoratori qualificati, in linea con il Green Deal e il Quadro Europeo delle competenze Imprenditoriali (EntreComp). La forza e l'esperienza dei cluster consolidati e in via di sviluppo continueranno a rafforzare le competenze, a sostenere la crescita dell'industria tessile e a presentare opportunità per una ricerca mirata che dia un forte impulso al settore tessile.

ADDTEX è iniziato nel 2022 e in una prima fase la ricerca si è focalizzata sull'analisi del divario tra l'offerta formativa e le reali esigenze del settore. Innanzitutto è stata condotta una ricerca a tavolino (*desk research*) per identificare le innovazioni, le opportunità e le sfide che devono affrontare l'industria tessile, gli istituti di istruzione superiore e i centri di formazione professionale. In un secondo momento è stata avviata la ricerca sul campo (*field research*), grazie al coinvolgimento di 94 partner appartenenti al mondo dell'industria. Sono seguiti incontri, *workshop* e *living lab*, che hanno fornito una piattaforma per condividere idee e raccogliere informazioni rilevanti per le sfide del settore tessile.
Queste metodologie hanno contribuito a identificare in modo efficace le complesse sfide che l'industria tessile deve affrontare in relazione alle pratiche sostenibili e alla circolarità, ai sistemi intelligenti e agli strumenti e alle tecnologie digitali innovative nel settore.
Per colmare le lacune individuate, è necessario un approccio combinato e olistico, che favorisca la transizione digitale e verde dall'ingresso dei laureati e dei lavoratori qualificati nel settore, al sostegno di team già affermati che cercano di aggiornare le proprie competenze, assicurando che rimangano attivi e resilienti al cambiamento.
Facilitare il trasferimento e la condivisione delle conoscenze all'interno dell'ecosistema industriale è fondamentale per una crescita sostenibile e una transizione graduale.
Il progetto ADDTEX fornirà un supporto alle attività del cluster, coinvolgendo accademici e ricercatori in ricerche collaborative per promuovere nuovi approcci innovativi e multidisciplinari

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all'insegnamento e all'apprendimento. Il trasferimento di conoscenze e lo scambio di competenze saranno supportati da strumenti didattici e corsi online aperti su larga scala (MOOC) che coinvolgono i team esistenti attraverso piattaforme accessibili che possano mettere in contatto laureati e lavoratori qualificati con l'industria e incoraggiare la co-creazione tra il mondo accademico e quello industriale.

L'analisi raccoglie i risultati dei partner di ADDTEX, dei 47 enti di istruzione e formazione tecnico-professionale, dei 55 centri di alta formazione e università, delle 272 aziende tessili.

Le aziende che hanno partecipato alla ricerca hanno fornito informazioni e approfondimenti sulle sfide e sulle opportunità legate alle tecnologie verdi, digitali e intelligenti, identificando le aree in cui è possibile creare innovazione e ottenere risultati positivi attraverso l'apprendimento e la formazione. Questi includono:

VERDE

- Riduzione, gestione e riciclaggio dei rifiuti
- Consumo di energia e risorse
- Innovazioni in materia di fibre sostenibili e progressi tecnologici nella lavorazione e nel riciclo delle fibre
- LCA, Analisi del Ciclo di Vita, valutazione e tracciabilità in tutte le fasi e le aree critiche delle operazioni
- Innovazioni e progetti ambiziosi legati alla tintura, al finissaggio e alla gestione dell'acqua

DIGITALE

- Tecnologie legate alla ottimizzazione della produzione
- Tecnologie di sensori intelligenti per l'acquisizione dei dati
- Metodi di tracciamento e autenticazione
- Gestione dei database e sicurezza informatica
- Strumenti di progettazione ed evoluzione dei software

INTELLINGENTE

- Metodi di autenticazione intelligente e tecnologie RFID (identificazione a radiofrequenza)
- Compositi complessi ed elettronica integrata
- Innovazioni legate ai tessuti intelligenti
- Sistemi di smistamento intelligenti e Ai
- Comunicazione e marketing B2B con VR e AR

Sulla base di questi risultati, i partner di ADDTEX inizieranno a programmare e implementare il piano di lavoro 3 (WP3), che prenderà in considerazione i risultati di questo rapporto e li utilizzerà per sviluppare una serie di risorse specifiche per il settore, strumenti di formazione e di e-learning e MOOC per colmare le lacune identificate durante la ricerca e per supportare il settore tessile.

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PORTUGUESE

SUMÁRIO EXECUTIVO

O principal objetivo do projeto ADDTEX é apoiar a resiliência e o avanço sustentável do setor têxtil para a transição *GREEN*, *DIGITAL & SMART* através de práticas de aprendizagem e formação inovadoras. Os parceiros representantes da Alemanha, Eslovénia, Espanha, Grécia, Itália, Irlanda, Portugal, República Checa, Roménia e Suécia realizaram pesquisas ao nível da inovação, desafios e oportunidades, considerados críticos para o setor, e estabeleceram que o envolvimento estratégico entre representantes da indústria, as entidades de ensino superior (EES) e ensino e formação profissional (EFP) constitui uma estratégia assertiva para alcançar o objetivo do projeto.

272 empresas têxteis, 47 EFP e 55 EES participaram em diferentes sessões de colaboração nesta fase do projeto (*Meetup*: 87 empresas, 17 EFP, 18 EES; Investigação de campo: 94 empresas, 15 EFP, 18 EES; *Living Lab*: 91 empresas, 15 EFP, 19 EES). O mapeamento e a análise de lacunas resultaram numa série de recomendações em áreas específicas para a transições *green*, *digital* e *smart*.

Os materiais têxteis avançados são considerados um próspero subsector do ecossistema têxtil e vestuário em toda a Europa, devido ao elevado valor acrescentado e diferenciação. A inovação neste campo é fundamental para a construção da resiliência e competitividade do setor na EU, assim como na garantia da competitividade, particularmente em ambientes voláteis, incertos, complexos e ambíguos (VUCA - *volatile, uncertain, complex, ambiguous*), como a situação da pandemia COVID-19.

O projeto visa reforçar e estimular o sentido de iniciativa, as atitudes empreendedoras, *mindsets* e competências dos alunos, pessoal docente e trabalhadores qualificados, em conformidade com o *Green Deal* e o Quadro de Competências para o Empreendedorismo. A solidez e a especialização criada, assim como os clusters industriais continuarão a construir competências, a apoiar o crescimento do setor têxtil e do vestuário e a apresentar oportunidades para uma investigação orientada para o impacto do mesmo.

O trabalho apresentado neste relatório resulta da análise de lacunas que iniciou em 2022 e que contou, numa fase inicial, com uma investigação documental que permitiu identificar inovações, desafios e oportunidades enfrentadas pela indústria têxtil e os promotores de EES e de EFP.

Seguiu-se uma investigação de campo com o envolvimento de 94 parceiros industriais. A realização de *meet-ups*, *workshops* e *living labs* proporcionou a partilha de conhecimentos chave e a recolha de informação relevante. Estas metodologias ajudaram a identificar com sucesso os complexos desafios que a indústria têxtil enfrenta em relação a práticas sustentáveis e de circularidade, sistemas inteligentes, ferramentas e tecnologias digitais que visam inovar o setor.

Para colmatar as lacunas identificadas, é necessária uma abordagem combinada e holística, promovendo a transição digital e ecológica desde a fase inicial de entrada de licenciados e trabalhadores qualificados na indústria, através do apoio a equipas estabelecidas que procurem a atualização de competências, assegurando que estas se mantenham ágeis e resistentes no setor.

A facilitação da transferência e troca de conhecimentos em todo o ecossistema da indústria é vital para um crescimento sustentável e uma transição suave. O projeto ADDTEX apoiará atividades contínuas que envolvam académicos e investigadores em ações colaborativas para promover novas, inovadoras e multidisciplinares abordagens de ensino e aprendizagem. A transferência de

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conhecimento e a troca de competências serão apoiados através de ferramentas educacionais e Cursos Online Abertos e Massivos (MOOC - *Massive Open Online Course*) que envolverão as equipas existentes através de plataformas acessíveis que unem licenciados e trabalhadores qualificados com a indústria e estimulam a cocriação entre o meio académico e industrial.

Em suma, esta fase de análise reúne as conclusões dos parceiros ADDTEX, dos 47 promotores de EFP, dos 55 EES e 272 empresas do setor têxtil.
Este trabalho colaborativo permitiu disponibilizar informações sobre desafios e oportunidades relacionadas com a transição *Green*, *Digital* e *Smart* e identificar áreas onde a inovação e o impacto podem ser alcançados através da aprendizagem e da formação. Estas incluem:

GREEN

- Mitigação, gestão e reciclagem de resíduos
- Consumo de energia e outros recursos
- Inovações em fibras sustentáveis e avanços tecnológicos no processamento e reciclagem de fibras
- Análise do Ciclo de Vida (LCA), avaliação e rastreabilidade em todas as fases e áreas críticas de operações
- Inovações e projetos ambiciosos ligados ao tingimento, acabamento e gestão da água

DIGITAL

- Tecnologias ligadas à racionalização da produção
- Tecnologias de sensores inteligentes para aquisição de dados
- Métodos de rastreio e autenticação
- Gestão de bases de dados e segurança cibernética
- Ferramentas de *design* e desenvolvimento de *software*

SMART

- Métodos de autenticação inteligentes e tecnologias de identificação por radiofrequência (RFID)
- Compostos complexos e eletrónica integrada
- Inovações ligadas aos têxteis inteligentes
- Sistemas de triagem inteligentes e IA
- Comunicações e Marketing B2B usando RA (realidade aumentada) & RV (realidade virtual)

Com base nestes resultados, os parceiros ADDTEX irão planear e implementar a fase seguinte de trabalho (WP3) no qual será desenvolvido um conjunto de recursos específicos, ferramentas de formação *e-learning* e MOOCs para colmatar as lacunas identificadas através da investigação, tendo por âmbito apoiar o setor e o seu ecossistema.

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ROMANIAN

EXECUTIVE SUMMARY

Obiectivul principal al proiectului ADDTEX este de a sprijini reziliența și tranziția sustenabilă ECOLOGICĂ, DIGITALĂ & INTELIGENTĂ şi progresul în sectorul textil prin învățare și formare inovativă. Partenerii reprezentând Cehia, Germania, Grecia, Italia, Irlanda, Portugalia, România, Slovenia, Spania și Suedia au realizat un studiu despre inovațiile, provocările și oportunitățile esențiale pentru sector, stabilind că angajamentul strategic între reprezentanții industriei și furnizorii de învățământ superior (HEI), de educație și formare profesională (VET) reprezintă o modalitate asertivă pentru atingerea obiectivul proiectului.

272 de companii din domeniul textil, 47 VET și 55 HEI au participat în această fază a proiectului la diferite sesiuni de colaborare (Meetup: 87 companii, 17 VET, 18 HEI; Field Research: 94 companii, 15 VET, 18 HEI; Living Lab: 91 companii, 15 VET, 19 HEI). Prin această cercetare și analiză a decalajelor au fost făcute o serie de recomandări pentru asistenţă în domenii specifice tranziției ecologice, digitale și inteligente.
Materialele textile avansate reprezintă un subsector înfloritor în ecosistemul textilelor și confecţiilor în Europa, fiind bazat pe valoare adăugată mare și diferite oferte de comercializare. Inovația în acest domeniu este esențială pentru consolidarea rezilienței sectorului textil la nivelul UE și pentru asigurarea competitivității acestuia, în special în medii volatile, incerte, complexe și ambigue (VUCA), precum cele reprezentate de pandemia de COVID-19.

Proiectul își propune să consolideze și să stimuleze inițiativa și atitudinile antreprenoriale, mentalitățile și abilitățile cursanților, personalului academic și lucrătorilor calificați, în conformitate cu Pactul Ecologic European și Cadrul de competențe pentru antreprenoriat. Puterea și expertiza clusterelor industriale consacrate sau în curs de dezvoltare vor continua să dezvolte competențe, să susțină creșterea sectorului textil și să prezinte oportunități de cercetare specifice sectorului pe baza impactului.

Cercetarea care s-a concentrat pe analiza decalajelor începând cu anul 2022. Cercetarea bazată pe studiu documentar a fost utilizată pentru a identifica inovațiile, provocările și oportunitățile cu care se confruntă industria textilă și furnizorii HEI și VET. Ca urmare, cercetarea documentară a fost facilitată și prin angajamentul de succes a 94 de parteneri din industrie. Întâlnirile, ateliere de lucru și laboratoare (living labs), oferind o modalitate de a împărtăși informații cheie și a aduna informații relevante pentru provocările sectoriale. Gama de metodologii utilizate, a facut posibilă evaluarea provocărilor complexe cu care se confruntă industria textilă în legătură cu sustenabilitatea și circularitatea, sistemele inteligente și instrumentele sau tehnologiile digitale cu potential de a inova sectorul textil.

Pentru a compensa decalajele identificate, este necesară o abordare combinată și holistică, încurajând tranziția digitală și ecologică la nivelul absolvenților și a lucrătorilor calificați în industrie, şi până la sprijinirea echipelor de lucru care caută să se perfecţioneze prin calificări noi, asigurându-se astfel agilitatea în sector.
Facilitarea transferului schimbului de cunoștințe în întregul ecosistem al industriei este vitală pentru o creștere durabilă și o tranziție lipsită de probleme. Proiectul ADDTEX va sprijini activitățile continue ale clusterelor, implicând cadre universitare și cercetători în cooperare pentru a promova noi abordări, inovatoare și multidisciplinare ale predării și învățării. Transferul de cunoștințe și schimbul de abilități vor fi sprijinite prin intermediul unor instrumente educaționale și cursuri online (MOOC) pe platforme accesibile echipelor existente, absolvenților și lucrătorilor calificați din industrie pentru a încuraja colaborarea creative între sectoarele academice și industriale.

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Etapa de lucru pentru analiza decalajelor reunește concluziile partenerilor ADDTEX, a 47 de furnizori VET, 55 de HEI și 272 de companii textile.
Companiile care au participat la studiu au oferit perspective asupra provocărilor și oportunităților legate de tehnologiile ecologice, digitale și inteligente, identificând domeniile în care inovațiile și impactul pot fi obținute prin învățare și formare. Acestea includ:

ECOLOGIC

- Reducerea, gestionarea și reciclarea deșeurilor
- Consumul de energie și resurse
- Inovații sustenabile pentru fibre și progres tehnologic în procesarea și reciclarea fibrelor
- LCA, Analiza ciclului de viață, evaluare și trasabilitate în toate fazele și domeniile critice
- Inovații și proiecte ambițioase legate de vopsire, finisare și gestionarea apei

DIGITAL

- Tehnologii legate de eficientizarea producției
- Tehnologii pentru senzori inteligenţi pentru achiziția datelor
- Metode de urmărire și autentificare
- Managementul bazelor de date și securitatea cibernetică
- Instrumente de proiectare și evoluție software

SMART

- Metode inteligente de autentificare și tehnologii RFID de identificare prin radiofrecvență
- Compozite complexe și electronice integrate
- Inovații legate de textile inteligente
- Sisteme inteligente de sortare şi AI
- Comunicații B2B și Marketing pe baza tehnologiilor VR și AR

Partenerii ADDTEX vor începe planificarea și implementarea pachetul de lucru 3 (WP3), care va prelua rezultatele acestui raport și va utiliza concluziile pentru a informa și extinde o suită de resurse specifice industriei și instrumente de formare și învățare online și MOOC-uri pentru soluţionarea lacunele identificate prin cercetare și sprijinirea sectorului și a întregului ecosistem.

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SLOVENIAN

POVZETEK

Glavni cilj projekta ADDTEX je podpreti odpornost in trajnostni ZELENI, DIGITALNI & PAMETNI prehod in napredek v tekstilnem sektorju z inovativnim učenjem in usposabljanjem. Partnerji, ki zastopajo Češko, Nemčijo, Grčijo, Italijo, Irsko, Portugalsko, Romunijo, Slovenijo, Španijo in Švedsko, so raziskovali inovacije, izzive in priložnosti, ki so ključne za sektor; ugotovili so, da je strateško sodelovanje med predstavniki industrije in ponudniki visokošolskega (VŠ) ter poklicnega izobraževanja in usposabljanja (PIU) ustrezen način za dosego cilja projekta.
272 tekstilnih podjetij, 47 poklicnih in 55 visokošolskih izobraževalnih ustanov je sodelovalo v tej fazi projekta na različnih skupnih srečanjih (Začetno srečanje: 87 podjetij, 17 poklicnih izobraževalnih ustanov, 18 visokošolskih izobraževalnih ustanov; terenska raziskava: 94 podjetij, 15 poklicnih izobraževalnih ustanov, 18 visokošolskih izobraževalnih ustanov; »dogodek Living Lab«: 91 podjetij, 15 VET, 19 VŠ). S to raziskavo in analizo pridobljenih podatkov je bilo moč prepoznati vrzeli in podati vrsto priporočil za pomoč na področjih, specifičnih za zelene, digitalne in pametne prehode. Napredni tekstilni materiali so uspešen pod-sektor v ekosistemu tekstila in oblačil po vsej Evropi, ki temelji na visoki dodani vrednosti in diferenciaciji kot edinstvenem prodajnem predlogu. Inovacije na tem področju so ključnega pomena za grajenje odpornosti in konkurenčnosti evropskega tekstilnega trga, predvsem v negotovih, kompleksnih in dvoumnih časih (VUCA), na kar nas je opozorila tudi pandemija COVID-19.
Projekt želi okrepiti in spodbuditi občutek za iniciativnost in podjetniško držo, miselnost ter spretnosti pri učencih, izobraževalnem osebju in kvalificiranih delavcih v skladu z zelenim dogovorom in okvirom kompetenc za podjetništvo. Moč in strokovnost že uveljavljenih industrijskih grozdov, kot tudi tistih v razvoj, bo še naprej krepila kompetence, podpirala rast tekstilnega sektorja ter predstavljala priložnosti za specifične raziskave, ki spodbujajo tekstilni sektor.
Raziskava, ki se začela leta 2022, se je najprej osredotočala na analizo vrzeli. Sprva so bile izvedene raziskave obstoječih praks in literature za namen prepoznavanja inovacij, izzivov in priložnosti, s katerimi se soočajo tekstilna industrija ter ponudniki visokošolskih in poklicnih izobraževalnih ustanov. Nato so bile izvedene terenske raziskave, ki so vključevale uspešno sodelovanje s skupno 94 industrijskimi partnerji. Sledila so začetna srečanja, delavnice in dogodek »Living lab«, ki so ustvarila prostor in priložnost za izmenjavo opažanj, mnenj in zbiranje ključnih informacij, navezujoč na izzive tekstilnega sektorja. Preko uporabljenih metodologij so se uspešno razkrili izzivi, s katerimi se sooča tekstilna industrija v povezavi s trajnostnimi praksami, krožnostjo, pametnimi sistemi ter digitalnimi orodji in tehnologijami za inovacije v sektorju.
Da bi premostili prepoznane vrzeli je potreben celosten pristop, ki bo spodbujal digitalni in zeleni prehod od vstopa diplomantov in kvalificiranih delavcev v industrijo, do nudenja podpore že uveljavljenim ekipam, ki iščejo izpopolnjevanje in nadgradnjo obstoječih znanj, da v sektorju ostanejo odporni in prilagodljivi. Omogočiti lažjega prenosa in izmenjave znanja v celotnem industrijskem ekosistemu je bistvenega pomena za trajnostno rast in nemoten prehod. Projekt ADDTEX bo podpiral dejavnosti tekstilnega grozda, vključeval akademike in raziskovalce v skupne raziskave za spodbujanje novih, inovativnih in multidisciplinarnih pristopov k poučevanju in učenju. Prenos znanja in izmenjava veščin bosta podprta z izobraževalnimi orodji in množičnimi odprtimi spletnimi tečaji (MOOC), ki preko dostopnih platform vključujejo že obstoječe ekipe, povezujejo diplomante in kvalificirane delavce z industrijo ter spodbujajo soustvarjanje med akademskim in industrijskim sektorjem.
Delovni paket, ki je vključeval analizo vrzeli je združil ugotovitve in rezultate partnerjev projekta ADDTEX, 47 ponudnikov poklicnega izobraževanja in usposabljanja, 55 visokošolskih in 272 tekstilnih podjetij.
Podjetja, ki so sodelovala v raziskavi, so zagotovila vpogled v izzive in prepoznavanje priložnosti v povezavi z zelenimi, digitalnimi in pametnimi tehnologijami ter opredelila področja, na katerih je mogoče z učenjem in usposabljanjem doseči spremembe in inovacije. Tej vključujejo:

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ZELENO
• Zmanjšanje odpadkov, upravljanje z odpadki in recikliranje
• Poraba energije in virov
• Trajnostne inovacije na področju vlaken in tehnološki napredek pri predelavi in recikliranju vlaken
• LCA, analiza življenjskega cikla, ocena in sledljivost v vseh kritičnih fazah in na področjih delovanja
• Inovacije in ambiciozni projekti, povezani z barvanjem, končno obdelavo in upravljanjem z vodo

DIGITALNO
• Tehnologije, povezane z OPTIMIZACIJO proizvodnje
• Pametne senzorske tehnologije za zajem podatkov
• Metode sledenja in avtentikacije
• Upravljanje baz podatkov in kibernetska varnost
• Orodja za oblikovanje in razvoj programske opreme

PAMETNO
• Pametne metode avtentikacije in tehnologije RFID za radiofrekvenčno identifikacijo
• Kompleksni kompoziti in integrirana elektronika
• Inovacije povezane s pametnim in inteligentnim tekstilom
• Pametni sistemi za razvrščanje in Ai
• B2B komunikacije in trženje z uporabo VR & AR

Partnerji ADDTEX bodo začeli z načrtovanjem in izvajanjem delovnega paket 3 (WP3), ki se bo opiral na rezultate tega poročila. Zbrane ugotovitve bodo uporabljene za razvoj vsebin in orodji, specifičnih za sektor, ki se bodo s ciljem premostitve vrzeli, uporabljala za prenos znanja in izmenjavo veščin z izobraževalnimi orodji in množičnimi odprtimi spletnimi tečaji.

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SPANISH

RESUMEN EJECUTIVO

El objetivo principal del proyecto ADDTEX es apoyar la resiliencia y la transición y la transición VERDE, DIGITAL E INTELIGENTE en el sector textil a través de aprendizaje y formación innovadoras. Los socios que representan a la República Checa, Alemania, Grecia, Italia, Irlanda, Portugal, Rumanía, Eslovenia, España y Suecia han analizado las innovaciones, los desafíos y las oportunidades fundamentales para el sector; y han establecido un compromiso estratégico entre los representantes de la industria y los proveedores de educación superior (IES) y de formación profesional (FP) para lograr los objetivos del proyecto. 272 empresas Textiles, 47 FP y 55 IES han participado en esta fase del proyecto en diferentes sesiones colaborativas (Encuentro inicial: 87 empresas, 17 FP, 18 IES; Trabajo de campo: 94 empresas, 15 FP, 18 IES; *Living labs*: 91 empresas, 15 FP, 19 IES). Como resultado de estos encuentros, se han recopilado una serie de recomendaciones para ayudar en áreas específicas de las transiciones verde, digital e inteligente de la industria textil.

Los materiales textiles avanzados son un subsector próspero en el ecosistema textil y de la confección en toda Europa, basado en el alto valor añadido y la diferenciación como propuesta de venta única. La innovación en este campo es clave en el desarrollo de la resiliencia del sector textil de la UE y para garantizar su competitividad, particularmente en entornos volátiles, inciertos, complejos y ambiguos (VUCA), como los que se presentaron durante la pandemia de COVID-19.

ADDTEX tiene como objetivo fortalecer y estimular la iniciativa y actitudes, mentalidades y habilidades empresariales en los estudiantes, el personal de la educación y los trabajadores cualificados, en línea con el Acuerdo Verde y el Marco de Competencias de Emprendimiento. La fortaleza y la experiencia de los clústeres establecidos y en desarrollo continuaran reforzando las competencias, respaldando el crecimiento del sector textil y presentando oportunidades para la investigación específica que impulse el sector textil.

La investigación de esta primera fase que se centró en el análisis de la brecha en entre la formación que se ofrece y las necesidades reales del sector se llevó a cabo en 2022. Se realizó en primer lugar una búsqueda bibliográfica para identificar innovaciones, desafíos y oportunidades a las que se enfrenta la industria textil y los centros de formación profesional y universidades. Después se llevó a cabo una investigación de campo en la que participaron 94 industrias colaboradoras. Siguieron reuniones, talleres y *living labs*, que proporcionaron una plataforma para compartir ideas y recopilar información relevante para los desafíos del sector. Estas metodologías ayudaron a identificar con éxito los complejos desafíos a los que se enfrenta la industria textil en relación con las prácticas sostenibles y la circularidad, los sistemas inteligentes y las herramientas y tecnologías digitales innovadoras del sector.

Para disminuir las brechas identificadas, se requiere un enfoque combinado y holístico, que fomente la transición digital y ecológica desde la entrada de graduados y trabajadores cualificados en la industria, hasta el apoyo a los equipos establecidos que buscan mejorar sus habilidades, asegurando que permanecer activos y resilientes a los cambios.

Facilitar la transferencia y el intercambio de conocimientos en todo el ecosistema de la industria es vital para el crecimiento sostenible y una transición suave. El proyecto ADDTEX apoyará las actividades continuas del clúster, involucrando a académicos e investigadores en la investigación colaborativa para fomentar nuevos enfoques innovadores y multidisciplinarios para la enseñanza y el aprendizaje. La transferencia de conocimientos y el intercambio de habilidades se apoyarán a través de herramientas educativas y cursos masivos abiertos en línea (MOOC) que involucraran a los equipos existentes a través de plataformas accesibles que conectan a los graduados y trabajadores cualificados con la industria y fomentarán la creación conjunta entre los sectores académico e industrial.

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Las empresas que participaron en la investigación brindaron información sobre los desafíos y las oportunidades relacionadas con las tecnologías verdes, digitales e inteligentes, identificando áreas en las que se pueden lograr innovaciones e impacto a través del aprendizaje y la capacitación. Éstos incluyen:

VERDE
• Mitigación, gestión y reciclaje de residuos
• Consumo de energía y recursos
• Innovaciones de fibras sostenibles y avances tecnológicos en el procesamiento y reciclaje de fibras
• LCA, análisis del ciclo de vida, evaluación y trazabilidad en todas las fases críticas y áreas de operaciones
• Innovaciones y proyectos ambiciosos relacionados con el teñido, el acabado y la gestión del agua

DIGITAL
• Tecnologías vinculadas a la racionalización de la producción
• Tecnologías de sensores inteligentes para la adquisición de datos
• Métodos de seguimiento y autenticación
• Gestión de bases de datos y ciberseguridad
• Herramientas de diseño y evolución del software

INTELIGENTE
• Métodos de autenticación inteligente y tecnologías RFID de identificación por radiofrecuencia
• Compuestos complejos y electrónica integrada
• Innovaciones vinculadas a textiles inteligentes e inteligentes
• Sistemas de clasificación inteligente y IA
• Comunicaciones B2B y Marketing usando VR & AR

A partir de estos resultados, los socios de ADDTEX comenzarán a planificar e implementar el paquete de trabajo 3 (WP3) en el que se desarrollarán un conjunto de recursos específicos para la industria y herramientas de capacitación y aprendizaje en línea y MOOCs para abordar las brechas identificadas a través de la investigación y el apoyo al sector y su ecosistema.

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SWEDISH

ADDTEX-projektets huvudmål är att stödja motståndskraften och hållbara GRÖN, DIGITAL & SMART övergång och framsteg inom textilsektorn genom innovativt lärande och utbildning. Partnerna som representerar Tjeckien, Tyskland, Grekland, Italien, Irland, Portugal, Rumänien, Slovenien, Spanien och Sverige har undersökt innovationer, utmaningar och möjligheter som är avgörande för sektorn; och fastställde att strategiskt engagemang mellan branschrepresentanter och leverantörer av högre utbildning (HEI) och yrkesutbildning (VET) är ett självsäkert sätt att uppnå projektets mål.

272 textilföretag, 47 yrkesutbildningar och 55 högskolor deltog i denna fas av projektet i olika samarbetssessioner (Möt: 87 företag, 17 yrkesutbildningar, 18 högskolor; Fältforskning: 94 företag, 15 yrkesutbildningar, 18 högskolor; Living Lab: 91 företag, 15 VET, 19 HEI). Genom denna forskning och gapanalys har en rad rekommendationer gjorts för att hjälpa till inom områden som är specifika för gröna, digitala och smarta övergångar.
Avancerade textilmaterial är en blomstrande undersektor i textil- och klädekosystemet över hela Europa, baserat på högt mervärde och differentiering som unikt försäljningserbjudande. Innovation på detta område är nyckeln för att bygga upp motståndskraften inom EU:s textilsektor och för att säkerställa dess konkurrenskraft, särskilt i flyktiga, osäkra, komplexa och tvetydiga miljöer (VUCA), som presenterades genom covid-19-pandemin

Projektet syftar till att stärka och stimulera en känsla av initiativförmåga och entreprenöriella attityder, tankesätt och färdigheter hos elever, pedagogisk personal och yrkesarbetare, i linje med Green Deal och Entrepreneurship Competence Framework. Styrkan och expertisen hos etablerade och utvecklande industrikluster kommer att fortsätta bygga kompetens, stödja textilsektorns tillväxt och erbjuda möjligheter till effektdriven, sektorspecifik forskning.
Forskningen som fokuserade på gapanalys började 2022. Skrivbordsbaserad forskning användes för att identifiera innovationer, utmaningar och möjligheter som textilindustrin och leverantörer av högskole- och yrkesutbildningar står inför. Efter detta introducerades fältforskning och genom framgångsrikt engagemang från 94 industripartners. Möten, workshops och levande laborationer följde, vilket gav en plattform för att dela viktiga insikter och samla information som är relevant för de sektoriella utmaningarna. Utbudet av använda metoder har framgångsrikt avslöjat komplexa utmaningar som textilindustrin står inför i relation till hållbara metoder och cirkularitet, smarta system och digitala verktyg och teknologier som förnyar sektorn.
För att överbrygga de identifierade klyftorna krävs ett kombinerat och holistiskt tillvägagångssätt, som främjar den digitala och gröna övergången från tidigt inträde för utexaminerade och kvalificerade arbetstagare till branschen, till att stödja etablerade team som söker upp kompetens, för att säkerställa att de förbli smidig och motståndskraftig inom sektorn.
Att underlätta kunskapsöverföring och utbyte i hela industrins ekosystem är avgörande för hållbar tillväxt och smidig övergång. ADDTEX-projektet kommer att stödja fortsatta klusteraktiviteter, engagera akademiker och forskare i forskningssamarbete för att främja nya, innovativa och multidisciplinära metoder för undervisning och lärande. Kunskapsöverföring och kompetensutbyte kommer att stödjas genom utbildningsverktyg och Massive Open Online Courses (MOOCs) som engagerar befintliga team genom tillgängliga plattformar som förbinder akademiker och kvalificerade arbetare med industrin och uppmuntrar samskapande mellan den akademiska och industriella sektorn.
Arbetspaketet för gapanalys samlar resultaten från ADDTEX-partners, 47 yrkesutbildningsleverantörer, 55 högskolor och 272 textilföretag.
Företag som deltog i forskningen gav insikter i utmaningarna och erkända möjligheter relaterade till grön, digital och smart teknik, och identifierade områden där innovationer och effekt kan uppnås genom lärande och utbildning. Dessa inkluderar:

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GRÖN
• Avfallsbegränsning, hantering och återvinning
• Energi- och resursförbrukning
• Hållbara fiberinnovationer och tekniska framsteg inom fiberbearbetning och återvinning
• LCA, livscykelanalys, bedömning och spårbarhet över alla kritiska faser och verksamhetsområden
• Innovationer och ambitiösa projekt kopplade till färgning, efterbehandling & vattenförvaltning

DIGITAL
• Teknik kopplat till effektivisering av produktionen
• Smarta sensorteknologier för datainsamling
• Spårning och autentiseringsmetoder
• Databashantering och cybersäkerhet
• Designverktyg och mjukvaruutveckling

SMART
• Smarta autentiseringsmetoder och RFID-teknik för radiofrekvensidentifiering
• Komplexa kompositer och integrerad elektronik
• Innovationer kopplade till smarta och intelligenta textilier
• Smarta sorteringssystem och Ai
• B2B-kommunikation och marknadsföring med VR & AR

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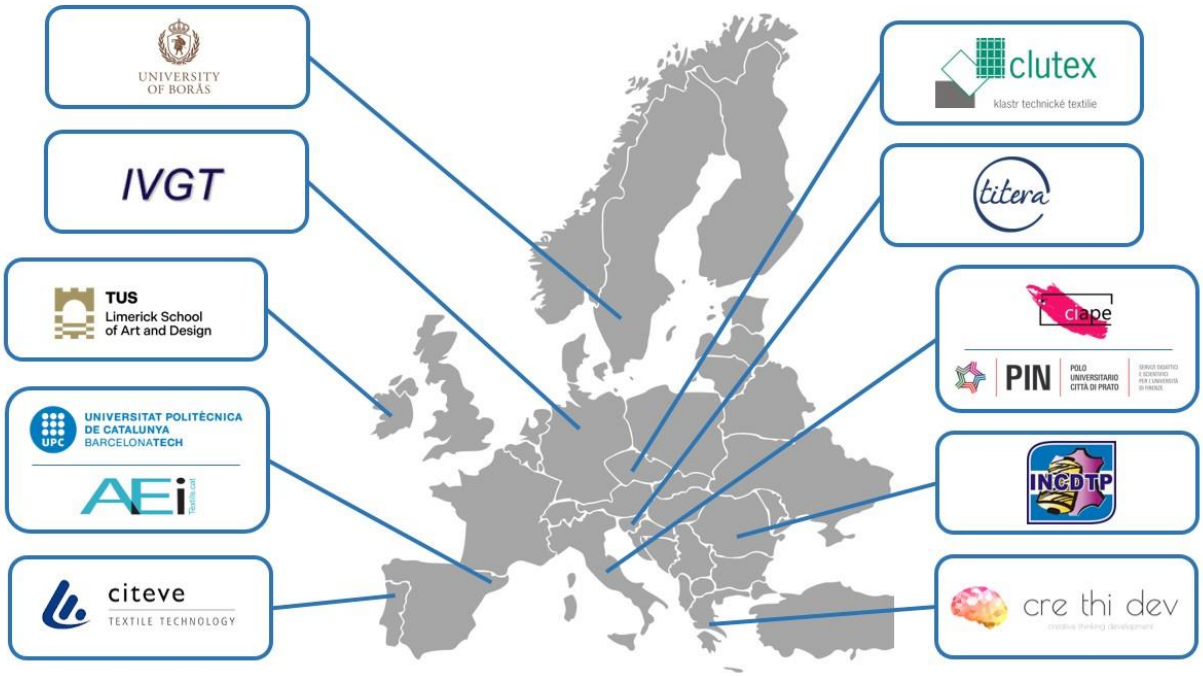

Figure 1: *partners and countries involved in ADDTEX project.*

2. Introduction

The following chapters will outline how the research was conducted, addressing the key areas of green, digital and smart innovations and the challenges impacting the EU textile industry. Identifying of existing initiatives, planned government provisions and reports has been carried out through desk-based research, and presents an overview of the current landscape supporting green, digital and smart transitions Europe wide.

Innovation in relation to green, digital and smart processes will be documented, establishing what currently impacts on these processes and presents challenges. Based on these challenges identified and the needs assessment carried out, opportunities and

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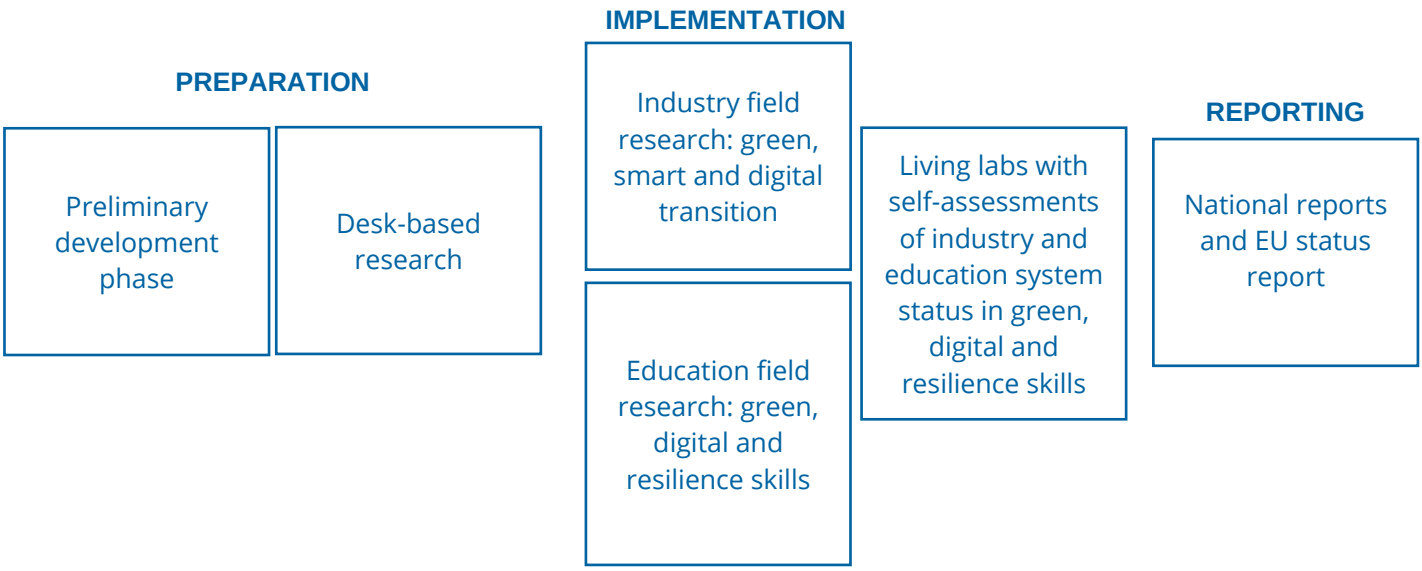
recommendations for positive and sustained impact will be outlined. These will be proposed as Priority Training Topics (PTT) resulting from the Living Lab.
The education and training mechanisms that currently exist in support of the textile industry will be outlined and delineated in respect to green, digital and smart pathways and ongoing research.
The conclusion of this report will consolidate the findings and summarise the insights from partners in Czech, Germany, Greece, Italy, Ireland, Portugal, Romania, Slovenia, Spain and Sweden.

3. Structure and Methodology of the Research

For the purpose of the work package 2 (WP2) report, preparation included desk-based research into indigenous textile companies and manufacturers of advanced textiles across Europe, investigation focused on the innovations and initiatives that are spearheading advancement in the sector in relation to sustainable practices, digital resilience, smart technologies and the latest developments in education & training.

The methodologies and activities implemented following the preparation consisted of industry meetings with the 272 Textiles companies, 47 VET and 55 HEI involving workshops and living labs where the project objectives were presented and the key focus areas pertaining to Green, Digital & Smart of WP2 were outlined. Participants were invited to respond in groups and share their insights relating to current challenges and recognition of opportunities for the sectoral development. The information gathered at each stage has been compiled into National reports by each of the partners, these reports inform this, the ADDTEX EU Status Report.

3.1 WP2 Tasks:



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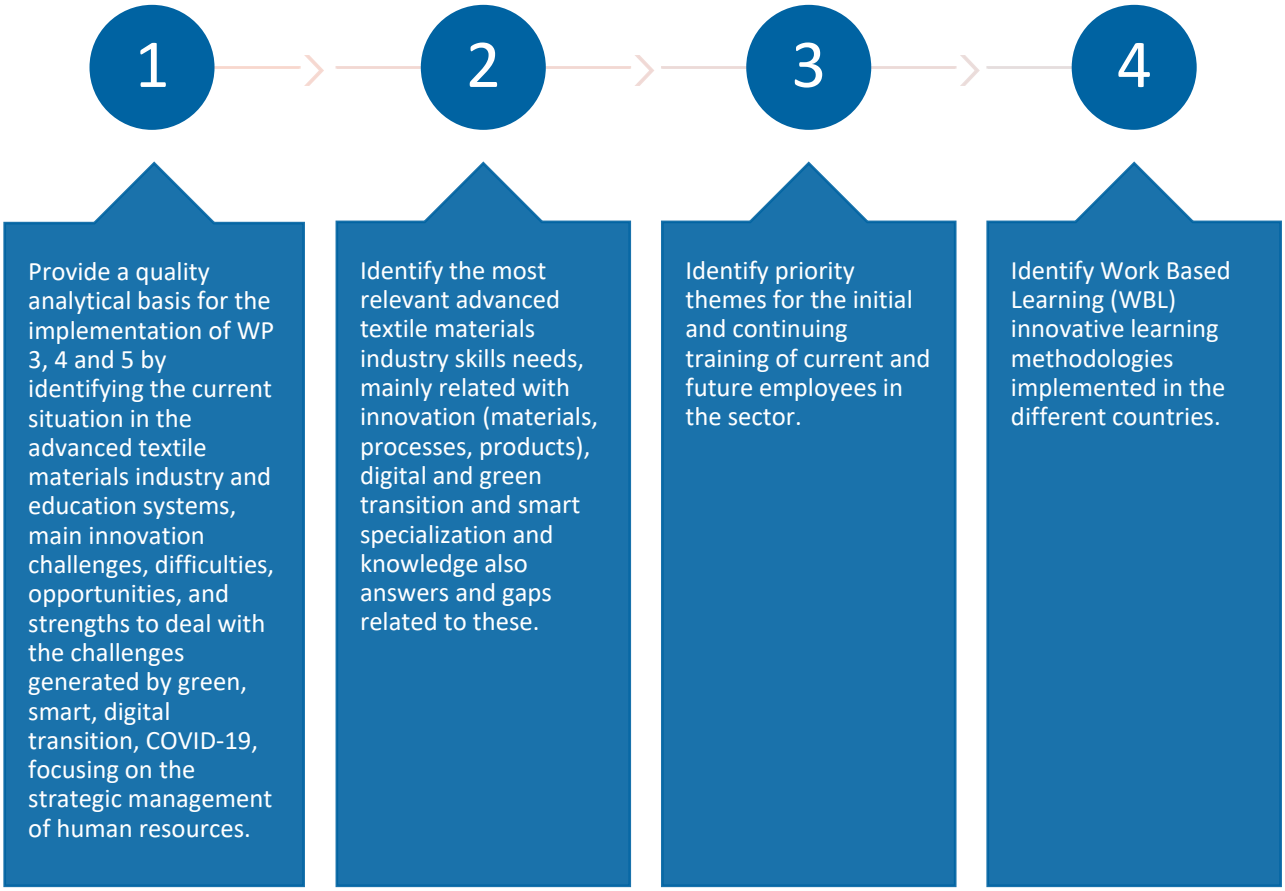
3.2 Specific aims of the WP2



4. Transition Readiness

Germany is well positioned to support the advanced textile industry as it is home to 9 universities where study is focused on highly advanced textile technology. Each of the universities has a special focus such as Textile Mechanical Engineering - Textile Manufacturing - Product Development - Smart Textiles - Innovative Textiles - Functional Textiles - Textile Electronics - Research and Development.

The challenges appreciated by **Spanish** companies seeking the smart transition are related to the integration of electronic devices, washable ones being a milestone, and textiles with different and improved functions.
Well-known issues of the textile industry also face companies in the green transition, such as water consumption and contamination, or the use of new tools, such as LCA (Life Cycle Assessment).

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To contribute to achieving its goal zero net greenhouse gas emissions by 2045, different textile and apparel industries in collaboration with the **Swedish** NGO Sustainable Fashion Academy launched STICA to develop action plans for attaining sustainable goals within the entire Swedish apparel and textile industry. The initiative is a major step that can involve all three major transitions such as green, smart, and digital transition.

Irelands textile industry includes manufacturers of woven textiles, knitted textiles, woollen carpet & rug producers, along with individuals representing Irish grown wool and fibre growers and textile upcycling facilities. Production techniques range from manually operated machinery to mechanised, automated and semi-automated production methods. Challenges lie in the lack of wool scouring and processing facilities in Ireland and lack of extensive fibre knowledge linked to the grading and quality assurances around the product as a raw material.

Czech Republic has acknowledged it is not well prepared for compliance of the ambitious recycling targets of the Action Plan in connection with textile waste for reasons constantly increasing volumes of this type of waste and hard-to-find official statistics on its production, the lack of recycling technologies and the obsolescence of the waste collection system.

Green materials for producing textiles have been identified by **Italian** partners, these are derived from regenerated plastics, citrus juices, sugar fermentation and other regenerated materials, which will have a major impact on the textile sector. Achieving certifications (e.g. GOTS Oeko tex ® STeP, Fairtrade Textile Standard, etc.) are considered as key requirements to accomplish specific parameters and not as factors determining a state of technological advancement.

INCDTP in **Romania**, develops multidisciplinary applicative research in textiles, clothing, leather, footwear, and rubber consumer goods. The main research activities include the development of multifunctional products obtained by applying nanotechnology and microelectronics; protection equipment made of textile and leather for environments with different risk degrees; textile and leather products for increasing the quality of human health and life.

The innovative solutions envisaged in **Portuguese** project HelpInTex are part of the important textile innovation, as well as a security method, particularly in crime against private property and health care. Multifunctional and intelligent mat solutions detect and communicate the presence or movement through a fully integrated sensor system completely integrated in the mat's textile structure.

In **Greece** the completed NanOrganic project focused on the development of nanostructured organic & inorganic materials and thin films for the production of organic electronic devices. For raw materials it is important that companies know about origins, ISO standards and regulations, how they were produced, under what conditions and how much waste did they produce.

In **Slovenia** companies strive to use less environmentally hazardous chemicals and fewer metal salts during the dyeing process while also trying to meet high standards regarding wastewater and lowering the amounts of drinkable water used during dyeing processes. Companies are purchasing

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materials outside the EU since the prices of raw materials in the EU are too high therefore almost non-competitive compared to suppliers from Asia.

4.1 Green transition Innovations & Impact

4.1.2 Textile Waste Solutions

Technology/innovation/ Changes	Description	Processes impacted by the technology/ innovation/ Changes	Examples (links..)
ALECOTERMO	The national project ALECOTERMO aims to use nonwoven 3D panels made of textile waste, vegetable and wool fibers as thermal insulation.	-reuse of textile waste; -manufacturing of 3D nonwoven panels for building insulation and energy efficiency	https://tinyurl.com/72p4ea39
Upcycled Products & Insulation using by product from the textile industry	A pilot creating new mattress and insulation components led by Cirtex is currently working with the cluster to incorporate wool textile by product into its shredding and upcycling process.	Currently companies manage waste independently through municipal waste collections or donations to schools. Implementation of circular design methods focusing on up-cycled insulation offer solutions for domestic waste.	https://tinyurl.com/yknzjzfp
Fibrenamics Green - Platform for the development of innovative products based on waste	A sustainable innovation project aimed at the incorporation and recovery of waste from various industries for the development of innovative products. Fibrenamics Green is being developed by the Fibrenamics International Platform of the University of Minho, in partnership with the Centre for Waste Recovery, With the main mission of waste recovery as a source of value creation for product development through the incorporation of design, engineering and creativity, resulting from involvement and university-company synergies.	Fibrenamics Green intends to aggregate waste in a common space from the various players in the entire value chain, aiding the recovery process, enhancing the transfer of interdisciplinary and multisectoral knowledge, in the development of products based on waste, driven by scientific and technological knowledge.	https://tinyurl.com/4hndf6ju
Automation in textile sorting	Green light for large-scale automated textile sorting facility in Malmo.	Textile sector being the major contributor to global environmental impacts, automated textile sorting is of utmost important tool to create circular system.	https://tinyurl.com/27wumzbs

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4.1.3 Fibre

Fibre blending technology	When used in combination with finer and soft wool, Galway wool makes an ideal fibre for both outer and inner worn garments. The staples are long enough for Worsted Spinning, giving good stitch definition and making it an ideal yarn for textured knits such as Aran. Fibreshed Ireland is launching Climate Beneficial TM fibres to build on quality assurances for Irish fibres.	Working with Irish wool producers to scale the use of native wool in Ireland. Education focused on wool grading, fibre composition, compatability and alternative uses involving the farming community, educational and creative sectors.	https://tinyurl.com/2p9umnrf https://tinyurl.com/548e9rb8 https://tinyurl.com/yckx8xaf
Fiber4Fiber	Initiative promoted by the Portuguese business group, Altri, through Caima, in collaboration with two entities of the National Scientific System: CeNTI and CITEVE. Fiber4Fiber project intent to develop optimised dissolving pulps, from Portuguese Eucalyptus globulus trees, to produce man-made cellulosic fibres – Lyocell and Viscose, that can be traced along the value chain.	This traceability will make it possible to distinguish products with sustainable origin from others similar that come from less responsible management sources, making it crucial to leverage the use of these fibres in increasingly demanding applications. These pulps will also be used to develop innovative functionalized lyocell fibres, to be marketed as premium products, as textile fibres and technical yarns.	https://tinyurl.com/5n7pckrk
Plant-based nylon-6	The Aquafil group in Trentino Alto Adige, with Texan biotech company Geno, has developed a technology to derive organic-based nylon from caprolactam, from the fermentation of sugars and not from petroleum-derived products. Aquafil and Genomatica, who signed their partnership four years ago, produced the first tonnes of caprolactam from raw material, converted it into nylon 6 polymer.	This bio-nylon is set to revolutionise the entire industry, which is globally worth $22 billion, by providing brands with new sustainable materials for daily use, from clothing to automotive and carpets. The material will be used in classical applications, such as yarns for textiles, carpets and plastic components. This new material can have three advantages: 1) This bio-nylon will help make entire supply chains more sustainable. 2) raw material nylon can be integrated into our depolymerisation process of	https://tinyurl.com/57v4va6d

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		end-of-life nylon products, creating full circularity. 3) It will facilitate the transition to more sustainable materials.	

4.1.4 Environment

STRATTON	The *STRATTON* project pursues an innovative approach and proposes a demonstration model of a rapid intervention unit made up of a complex composite reinforced with a woven textile structure, with high-tech features, designed to withstand complex conditions of use in the open sea.	-recovery of pollutants from water (hydrocarbons) -temporary vertical storage and horizontal transport of the water-hydrocarbon mixture	https://tinyurl.com/47skuv8p
LCA Resell, recycle and increase the lifespan of garments.	The organization aims at increasing the lifespan of garments by integrating sustainability which they believe is the way to growth.	It is one of the sustainability pioneers among Swedish brands. Since 2014, the brand has operated by the motto that 'sustainability leads the way to growth', with the lifespan of its garments as a primary focus. In 2015 Filippa K launched a new concept, the Collect program, whereby people get a discount on new purchases if they return garments they no longer want. By 2030 the brand aims to remake, resell or recycle 100 percent of collected garments.	https://tinyurl.com/2p8n3yed
Life Cycle Assessment (LCA) (and other Life Cycle analysis)	The Life Cycle Assessment (LCA) is the analysis of all the environmental impacts associated to a product or a process. In these cycles, inputs such as materials, energy, transport, and outputs like gas emissions, water treatments, by-products are considered. The use of an LCA allow determining and improving in a sustainable point of view parameters, process or materials in a process or product. However, their use is still incipient in industry. Moreover, the recollection of the data and the production of the inventories (Life Cycle Inventories) is expensive. Nonetheless, the inclusion and revision of BAT	All the process, including the reuse, recycle and end of life behavior.	https://tinyurl.com/yeyr898a https://tinyurl.com/2p8n3yed

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	(Best Avalaible Techniques) has been done after the analysis of LCA.		

4.1.5 Resource/Energy Consumption

SET, Save Energy in Textile SMEs	The project SET allows textile SMEs to improve their energy efficiency and achieve quantifiable economic benefits through efficient use of resources	The aim is to evaluate and improve energy efficiency in textile SMEs along the value chain in the textile industry: spinning/weaving/knitting/finishing.	https://tinyurl.com/yzjmrpcd
Initiative STICA	It helps set up science-based targets to reduce greenhouse gas emissions within Swedish textile and apparel industries.	Studies revealed that the majority of the apparel industry´s greenhouse gas emissions are generated in the value chain system, particularly during the fiber and material/fabric production.	https://tinyurl.com/mrx9v7ft
Water reduced processes	Water consumption and contamination is one of the main problematics in the textile industry. Many textile processes, such as cleaning, bleaching, finishing, dyeing and printing are one of the most consuming industrial processes.	Cleaning, dyeing, printing, finishing processes	https://tinyurl.com/z7cu8kkr

4.1.6 Innovations in Dying and Finishing

Hydraulic spray dyeing	A new dyeing process developed at the University of Boras turned into a startup company is now addressing the environmental issues in textile dyeing. The device was explored for its profitability and productivity with dramatically reduced waste water volumes, the greatly reduced energy and chemistry consumption and the increased production speed and consistent and predictable quality.	Textile dyeing and finishing	https://tinyurl.com/mwahme8x
Enzymatic treatments	Enzymes are applied in a large variety of industrial processes due to its highly specific, efficient, non-toxic, and eco-friendly behavior. In the textile industry, it's interesting is increasing fast.	Fabrics finishing, dyeing, recycling process, water treatments in textile effluents	https://tinyurl.com/4e74ywac

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Clothing as a service	a business model that allows you to return the clothing after it has been worn to the seller (manufacturer), who then recycles the clothing (material), has a greater overview of the material, recycling is facilitated	Waste as a resource	https://tinyurl.com/4bxj6ktv

4.2 Digital Transition Innovations and Impact

4.2.1 Production

Technology/innovation/ Changes	Description	Processes impacted by the technology	Examples (links..)
Automated real-time inspection for Circular Knitting Machines	Portuguese company Smartex has developed the first automated fabric inspection system for Circular Knitting Machines. Advanced camera vision system that reduces defective production to close to 0% in Circular Knitting Machines, including lycra faults, yarn thickness, holes, needle defects, and more. The system is able to create a roadmap of possible types and coordinates of defects and offer insights about the efficiency of machines and percentage of defective production.	Defects are detected & automatically recorded on the X Y roll map, so their downstream impact in the supply chain can be minimized. Detects recurring defects & stops the machine before it's too late. This technology eliminates textile waste during the manufacturing process.	https://tinyurl.com/bdfdwthe
Machine learning	Technology enabling defect detection, quality control of product, print, pattern, also train to accept defects within a certain error range. After feeding it numerous good, bad, and acceptable patterns, it will be able to distinguish completely incorrect knit patterns from very slightly incorrect but still acceptable patterns.	Production	https://tinyurl.com/yc89acka

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Digital DyeHouse Planning	Support for shade matching and colour-recipe creation and optimization, advanced program with AI.	Production.	https://tinyurl.com/y5xr6xdv
SaaS systems	Software as a service	Tailr is an innovative cloud- based SaaS platform that helps clothing brands streamline production, achieve sustainability goals, & ensure consistent sizing from season to season that has the potential support Irish and international markets	https://tinyurl.com/4z7jryyd

4.2.2 Communications

Meta Real	Riopele company – meta-collection. Riopele is deepening its efforts to digital transition and is unveiling its first-ever collection in the Metaverse. This initiative will enable "the customers, suppliers and partners of Riopele to experience the fabrics in the digital world"	With this technology, which falls within the framework of the project designed to digitalise the samples and provide virtual prototypes of products, Riopele is placing all of its tools in the Metaverse to enable its customers to fully analyse the collection, verify their functionalities and visually experience.	https://tinyurl.com/2p88k85z
Virtual design of garments	CAD/CAM, AI software tools for 3D modelling of apparels, fashion	Design of product, production, communication with customer	https://tinyurl.com/5ch4b4pj

4.2.3 Industry Eco-systems

Cyber Security	Threat of data breaches and fraudulent activity impacting on business and consumer confidence.	Client and consumer confidence reinforced. GDPR Secure Data In-house operations efficiency	https://tinyurl.com/2ww6f8e2
Tracking systems for textiles	Tracking systems allows following all the steps and materials in a product by using Blockchain or similar technologies. The use of this information could lead to a better management of the distribution or the recycling of the components in the textile products and byproducts.	All the textile chain: from materials to end life.	https://tinyurl.com/3aybpuwx
ERP Systems (Enterprise resource planning)	On-time information about different operations such as links between stock and shop, links between	Management of different sectors from commerce to sales, from design to production.	

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	laboratory results, and the production line.	
E-documents; E-personal employee folders	Digitalisation of employee data (documentation related to the employment relationship, holiday leaves, timesheets, health, safety, pay slips) helps Finance and Accounting and Human Resources departments.	More effective work of Accounting and Human Resources departments.

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4.3 Smart Transition Innovations & Impact

4.3.1 Intelligent Textiles

Technology/innovation/ Changes	Description	Processes impacted by the technology	Examples (links..)
Smart and Interactive textiles	Clothing that monitors your health or measures your movements. Technology that makes it possible to recycle textile fibers and reuse them	The platform focuses on sustainable textiles, smart textiles, and Industry 4.0 attributing towards advanced technology	https://tinyurl.com/y47yefb9
IHeatex Multifunctional Felt and Intelligent Hybridization Project	New multifunctional, intelligent hybridization, three-dimensional structures and architectures with active moisture and heating management properties. The developments are directed to two typologies of felted products for application in home textiles and hotels: bath articles and kitchen articles. Consortium composed by J.F. Almeida company, CITEVE and CeNTI.	This project promotes significant advances, in particular in spinning, weaving and finishing technologies.	https://tinyurl.com/2p99p5rf
Washable sensors on textiles	One of the challenges in smart textiles is the development of washable sensors. Wearable smart textiles are designed to monitoring different parameters of our life and improve it thought the analysis of these data. However, one of the main inconvenient is the sanitising process of these materials.	Raw materials production, product manufacture	Gow trainer - Weartech
Smart textiles	Textiles enabling the integration of electronic functions, now a current topic of autonomous charging of these systems - especially solar cells and their connection with flexible storage systems	Utility value of textile, product manufacture, recycling	https://tinyurl.com/4kprewu2

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4.3.2 Authentication

Smart authentication methods Anti-counterfeiting tags Protected IP-Donegal Tweed, Irish Linen and Aran Knitwear Certification	Smart authentication methods to validate IP and certification for clients and customers supporting transparency, traceability and bolstering consumer trust.	A framework that will cover regional textiles such as Donegal Tweed & Aran knitwear and is similar to the protection offered to Champagne under their "Protected Geographical indication" (PGI) status.	https://tinyurl.com/2n2awu5uhttps://tinyurl.com/ykpyaud6 https://tinyurl.com/2w3u433p https://tinyurl.com/4bnvrdcf
Nesting-Optimized Leather Cutting process	Used on daily basis, a program using Artificial Intelligence (Ai) to recognise irregularities in material and adapt pattern layout for maximal material use and minimal material waste.	Production and material preparation processes. Nesting machines use some level of artificial intelligence to recognize dimensions, shapes and irregularities on leather skins to optimize the cutting process.	https://tinyurl.com/yckr3sfr

5. Existing Initiatives, projects, reports and development in the Green, Digital & Smart transition

5.1 Government Initiatives

- Mobilising Agenda for business innovation is exemplified in CIVETEs coordination of Giatex: Intelligent Water Management in the textile and clothing industry. This project aims to address the challenges faced by textile finishing companies in terms of intensive water consumption. It aims to develop a set of tools that allow companies to:
    - Reduce the specific water consumption (use of less intensive finishing technologies and adoption of treatment technologies that allow water reuse).
    - Support the decision on the final destination of water (through the integration of monitoring and process control systems and a new support tool for water management).
- TEXP@CT – Is an innovation pact for the digitalisation of the Textile and Clothing sector.
- CIRCULÉIRE, a public-private parntership, has developed the Fashion and Textiles Good Practice Sectoral Guide intending it to be a point of reference and strategic guide for the textile industry, apparel and clothing production facilities, textile recycling

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facilities and importantly extending guidance to stakeholders integral to the value chain, consumers, retailers and policy makers

5.2 Fibre Innovations

Company Tekstina is one of twelve companies partaking in the project “New Cotton” where textile waste is collected and sorted, and regenerated into a new, man-made cellulosic fibre that looks and feels like cotton – a “new cotton” using Infinite Fiber Company’s textile fibre regeneration technology.

BleNaBis deals with research into the possibilities of applying renewable fiber sources - fibers from oilseed stalks (waste from the production of a nutritional source), bio-polyamide and their mixtures for the production of yarns intended for interior textiles. The aim is to ensure the usability of renewable fibrous biodegradable materials as a replacement for synthetics from fossil sources and thereby reduce environmental burdens.

A feasibility study published in July 2022 assessed market opportunities for Irish wool. This study was commissioned by the state, in large part due to the substantially low return on wool stocks in recent years. Several market sectors were assessed. Barriers to advancements and meaningful establishment in identified markets are outlined, along with recommendations for the routes to accessing these markets.
The recommendations include, but are by no means limited to; branding of Irish wool, establishing a wool hub, establishing an innovation cluster, Life Cycle Assessment frameworks, subsidised apprenticeships for wool sector, expansion in genetics and breeding databases, wool fibre applications, RD&I support.

TreeToTextile project, involving 3 partners (H&M, IKEA and Stora Enso), aims to develop a new fiber type using renewable forest materials and transforms cellulose into textile fibers. The production process involves reduced energy and chemical consumption, making it more sustainable and cost-effective than standard production.
XLOOP, developed by Boxmark company is a compostable leather, where the production waste is biodegradable. In the tanning process, chromium or glutaraldehyde are avoided entirely and only an organically based, synthetic tanning agent is used.
Aquafil, a leading manufacturer of synthetic fibres. In particular, their ECONYL® yarn is a nylon obtained by recycling discarded carpets, disused fishing nets and fabric scraps. The company has also developed a technology to separate nylon 6 from copper oxide in aquaculture nets: it is a circular process, where each component of the fishing net finds an industrial destination and not landfill.
RECYBUILDMAT is a project developed by the group TECTEX of the UPC. The project aims to develop to develop and characterize sustainable building materials based on cement or lime matrix and additives from agricultural by products reinforced with nonwoven fabrics produced from textile waste.

5.3 Processes

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- Manteco is a textile company in Prato that has patented MWool®, the new generation of recycled wool, obtained both from manufacturing waste and from pre- and post-consumer garments. It is a wool with more than 1000 colours obtained thanks to the exclusive Recype® process that combines recycled fibres of different shades without the use of chemicals.
- Saluzzo Yarns, which has patented the Newlife™ fabric, which is a certified system of recycled polyester yarns obtained entirely from post-consumer bottles, which are transformed into a polymer through a mechanical process, and not a chemical one, until the yarn is produced.
- The German Institutes for Textile and Fiber Research (DITF), together with various partners in the CORA project, are now developing a direct-air capture system that continuously removes CO2 from the atmosphere. The annoying filter change is eliminated. The basis of the future plant are cellulose fibers to which the CO2 binds.
- Project partner have succeeded in producing polyurethanes that melt like thermoplastics and can thus be processed on melting spinning plants without the use of solvents. Suitable melt spinning processes were developed at the ITA for the processing of these polymers. Nice side effect of this so-called thermoplastic polyurethane (TPU): Because CO2 is processed from exhaust gases in the TPU, the climate is protected. The CO2 no longer enters the atmosphere, but is used sensibly.
- RESET addresses 6 key themes: Recycling in textile and waste disposal, Water consumption and energy saving, sustainable company organisations, New sustainable chemistry, including reduction of chemical substances, Smart textiles and new ways of production, Eco-creativity, natural fibres, short value chains, New materials and new application
- TRICKProject supports the adoption, tracing and demonstration of sustainable approaches by means of an innovative and circular product information management system based on Blockchain and able to provide stakeholders of the supply chains and final consumers with all the relevant data needed to implement end of waste practices and aware purchasing choices. https://www.trick-project.eu/
- Digitalisation of a series of fabrics selected from the archives of Marini Industrie and the Museo del Tessuto in Prato, as well as some headgear chosen from the collection of Renaissance costumes of Manifatture Digitali Cinema of the Toscana Film Commission.

5.4 Industry Ecosystems

- Atelier Riforma is a Turin-based start-up with a strong social vocation that, in about a year and a half, has collected more than 8,000 garments, saving them from landfill. The collection supply chain is transparent and all garments are catalogued and traced. The garments are processed by the start-up's network of artisans: a network of professional tailors, mostly young women, as well as social tailors. Collaborations also include fashion schools: an opportunity to train the professionals of the future on upcycling in textiles.
- There are initiatives such as SFIS5 (Sustainable Fashion Innovation Society) that constitute a platform for the green transition with more than 2000 brands, where fashion sustainability joins technology. The platform's objectives are to enhance fashion and Made in Italy, promote the sustainability of the textile production process, facilitate

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innovation in the related supply chain, increase the circular economy, publicise respect for the planet and raise consumer awareness. The initiative includes the set-up of a platform that creates a community of companies, connects textile and clothing companies to sign up for the initiative to receive support.

- GALACTICA project aims to support the creation of new industrial value chains around textile and aerospace sectors based on advanced manufacturing.
- The vision is to drive cross-sectoral innovation to boost new market opportunities, revenues and improve productivity.
- Projects – IDEAM In-Transit is a HORIZON project facilitating business model innovation for green and digital transitions with a focus on the textile, construction and aerospace industries. Engaging SMEs through individual assessments to support growth in sustainable, measurable ways and supporting businesses with coaching and lump sum funding for green and digital transitions.

5.5 Smart Innovations

- Triturats La Canya (a textile recycling company) comes up with novel approach that lies in the implementation of a semi-automated sorting solution -based Near-infrared Spectroscopy (NIR) or AI/computer vision – that will assist and maximize workers efficiency that will be 2x more productive (in number of pieces sorted per hour, based on color and composition), allowing to reach an impressive sorting accuracy of more than 95%.

- The goals of YFATRONIC were focused on the development of organic photovoltaic devices (OPVs) onto flexible substrates (polyester films, polyester textiles) by printing techniques which will be characterized by significant operational stability, long lifetime (1-2 years), high efficiency (4-5%) and the their flexible use on textile products (e.g. clothes).
  The Smart Material & e-Textile Innovation Lab
- https://waltoninstitute.ie/industry/industry-services/testbeds Testbeds and laboratories to expand awareness and invite collaboration in the areas of smart material and e-textile research and development are supported at the innovation lab housed in the Walton Institute. Industry standard equipment including conductive inkjet printers and technical embroidery machinery of an industry standard facilitates smart garment prototyping and concept development. Applications for these technologies extend to the areas of wearables for advance healthcare monitoring, wellbeing, smart interiors, adaptive and smart fashion and intelligent textiles.
- ERASMUS+ HACKTEX project aims at developing innovative pedagogical tools to improve the skills of engineering students on higher education in relation to innovation and, particularly, in the field of smart textiles.

6. Impact of the Green, Digital and Smart processes in the industry

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6.1 Green

Innovation linked to green and sustainable futures for the textile industry concerns **energy consumption, waste materials, fibre quality and sustaining skills.** Solutions for sustainable **waste management, supply chain issues** and **fibre quality** were also indicated as areas where innovation is required.

The **shortage of skilled** workers in the textile industries is being felt by the companies who participated in the report. Working on the **generational transition** in textile companies is also an area which requires support going forward.

Basic chemistry education for the current and future employees along with the necessity of understanding timings, temperature, chemical, and mechanical agitation was also indicated as areas where increased knowledge would be beneficial. It is urgent to prepare technicians with more **transversal skills, namely legislation, technologies, eco-engineering and design for sustainability.**

Knowledge about the **lifespan of materials** is key. Companies are interested in a course that would focus on information on how to assess the lifespan of materials, how to increase it, and what decreases it. **Biodegradability and compostability** information linked to the properties of textiles, prerequisites for the degradability of materials without negative impact on the environment. **Recyclability** information about what properties a textile product must have (material composition, design,...) in order to be recycled, knowledge about recycling technologies. **Energy intensity** of production and practical examples and instructions for production design and consideration of ecodesign requirements according to the relevant guidelines, economic aspects and analysis. The **investment requirement** of green technologies. Setting up a comprehensive **system of collecting textiles**. **Composition information flows** - importance of storing information on the composition of materials allowing for easier recyclability.

Research on **sustainable raw materials, digital product passport, new bio-based and bio-nylon fabrics,** new fabrics made from **deadstock and defective textiles,** new fabrics made from **regenerated plastics.**

Companies recognise that incentives such as **tax breaks** for responsible textile waste management **and subsidised apprenticeships** to support entry-level workers would be advantageous to the green transition and sustainable industry growth.

6.2 Digital

Cybersecurity – this area is important, companies see this as a barrier to wider use of digital platforms, cloud, distributed databases. **Digital passport** of the product and technologies that allow the desired information to be stored and displayed. **Data** collection and sorting, methods of evaluation. **Visualisation** tools for product design and production modelling. **IoT** knowledge for remote connection of text components to the Internet, control, matching of functions. **AI & machine learning** for production quality monitoring and sample evaluation. **Blockchain** and where it is being used effectively. **Online platforms, websites, configurators** all this for communication with the customer, presentation.

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The integration of **automation and digitalisation** of the entire process, whether the connection to suppliers, to clients or in the internal restructuring of the companies**.**
Innovation linked to digital encompasses **-cyber security, databases for in-house operations & recruitment, e-commerce and marketing support, digital archiving with machine servicing and technical support and maintenance** also being and area of concern.
Certification, traceability and authenticating products is important to the companies in communicating to their clients and customers and also in the **protected status** of the textiles being produced**.**
Smart systems that authenticate product such as **QR** codes add value to the product and instil consumer confidence**. Fraud prevention** systems utilising machine learning & Ai provide security to companies.
Computer programs that help sectors of **Sales, Human Resources, Commerce, Design and Production, and Inventory management** to better optimize their work processes, to have real-life information about certain areas of work, and to establish direct links and information flow between certain areas of the company.
In-house education and training to equip IT professionals with basic knowledge in textile as well as to equip textile professionals with **basic knowledge in digital tools.**

6.3 Smart

LCA assessment, data gathering, automatisation supported by emerging technologies **AI and blockchain for textile traceability and sustainability passports**. **Data management** (from product and from production process). **Energy efficiency and sustainability** is a key area of concern and the demand exists to build on abilities to identify weak points in sustainable design, energy consumption and processing.
Robotisation of production lines for specific processes and the implementation of digital systems for making products (tailoring, printing). Access to **modern machines** that will help in the production process and consume little electricity and auxiliary energy.
Intelligent waste selection and **intelligent defects detection-based video/image processing and AI.**
QR code technologies on garments with information on the production chain, fashion renting (garment rental), **NFT (Non Fungible Token**) to create **unique digital products, digitalise fabrics, digital marketing** tools to increase the visibility of products and companies.
There are developments being made the area of **passive smart textiles and biocomposites,** generated with native flax and hemp with potential applications for the automotive and aerospace industries which have the potential to **embed electronics & sensors.** The need exists to understand the processing requirements for a much wider range of fibre and resin systems including **bio-composites, recyclable thermosets, bio-based resins, bio-based carbon fibre** and integration of electronics.

7. Priority Training Topics, PTT

7.1 GREEN PTT

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The Green PTT areas where focus will occur relates to:

- Waste mitigation, management and recycling
- Energy and resource consumption
- Sustainable fibre innovations and technological advancements in fibre processing and recycling
- LCA, Life Cycle Analysis, assessment and traceability across all critical phases and areas of operations
- Innovations and ambitious projects linked to dying, finishing & water management

7.1.1 Energy

Functional areas of the company	Technology/innovation/ Changes	Knowledge needed to perform the process	Priority Training Topics to be addressed
Strategic management	Energy restructuring (Biomass, solar panels,...). Choosing greener machines and processes.	Advancements of energy-efficient technologies in industry. Factory structures Existing infrastructure Maintenance of new technologies. Monitoring software. Planning and organisation to create efficiency productive energy.	Maintenance. Planning and organisation. Ecological, sustainability and circularity criteria Sustainable energy. Recycling. LCA studies, carbon footprint and environmental declaration. Eco-efficiency in the value chain. More eco-efficient production processes. Digitisation. Automation. Sustainable functionalisation by process.

7.1.2 Traceability

Raw material purchasing sector	Regulation / Legislation. Recycling of materials.	Recycling's impact on the environment. Internal improvements. Sustainable fibres and materials (origin, characteristics, composition, other technical specifications).	Traceability. Regulation. Eco design. Recycling materials. Product composition. Fibres and textile structures (more sustainable). Choice of sustainable materials.
Quality	New processes.	Legislation / regulation.	European legislation. Eco-labels. GOTS/OCS.

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			GRC/RCS. Material quality and durability.
Production	Traceability	Process and product life cycle knowledge, supply chain traceability	Blockchain, certifications, sustainable supply chain management
Design of production	Ecodesign Life Cycle Assessment (LCA) (and other Life Cycle analysis) Ecodesign	LCA methodology Energy and material consumption material properties of fibers textile technology knowledge about chemicals, especially PFAS chemicals Sustainable transport and logistic systems	LCA for different types of materials – natural and chemical Carbon footprint Sustainable transport and logistic systems Knowledge of PFAS substances

7.1.3 Waste & By-Product

Post-Production Waste	Sustainable waste management solutions for wool and linen based product	By-product applications for textile waste. EPA registration process for categorisation of By-product	Wool waste regeneration techniques for protein fibre product. Linen waste regeneration techniques for cellulosic fibre product. Life Cycle Assessment, LCA framework EPA registration process for categorisation of By-product
Research & Development	New Materials and Reuse of Waste	New technologies to recycle, new machinery to recycle, new fabrics, new legislative framework	Environmental impact assessment metrics, the recycling system, lean production, certifications, fabric types (e.g. bio-based and bio-nylon)
Raw materials	Regulations and ISO	For raw materials it is important to know about origins, how they were produced, under what conditions and how much waste did they produce.	Transparency Follow regulations and ISO standards Bring awareness Train the local market

Waste management	Procedures to recycle fibres on company premises, procedures to recycle manmade fibres with high amounts of Lycra, avoiding incineration.	Knowledge in fields of chemistry, engineering, ecology, sustainability	Chemistry, Engineering, Ecology, Sustainability

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	Building and operating facilities to collect, recycle and reuse textile waste directly from production lines with no need to outsource service providers.		

7.1.4 Processes

Water Reduced Processes	Environmental regulations and policies	Changes and new environmental regulations and policies	
Production	Ecodesign in the area of energy in the area of energy intensity of production Water reduced processes Energy reduced processes PFAS chemicals, microplastics	Regulations in the field of ecodesign Material properties of recycled fibers Textile technologies Recycling technology Work with chemicals Prerequisites for increasing lifetime and controlled fiber release	Regulations in the field of ecodesign Material properties of recycled fibers Recycling technology Work with chemicals Prerequisites for increasing lifetime and controlled fiber release

7.2 DIGITAL PTT

The Digital PTT areas where focus will occur relates to:

- Technologies linked to streamlining production
- Smart sensor technologies for data acquisition
- Tracking and authentication methods
- Database management and cyber security
- Design Tools and software evolution

7.2.1 Databases

Functional areas of the company	**Technology/innovation/ Changes**	**Knowledge needed to perform the process**	**Priority Training Topics to be addressed**
Internal databases	Cyber security	Vulnerabilities and systems susceptible to breaches.	Cyber security best practice GDPR and communications

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Consumer facing platforms			
Data analysis Data protection	IoT solutions Cloud archiving Working with confidential data	Archiving the data Reading the data in cloud The use of internal database	Basic in computer science – course Practice in data analysis – course Understanding “safe” protocols – course

7.2.2 Design Tools

3D design and pattern	All companies use the method of digital design and pattern creation in the supply chains.	Faster processes and less time. Digital methods have reduced drastically the waste from several stages of the supply chain. A barrier that is soon to be overcome is the lack of knowledge or the limited amount of it.	Creating new channels and finding new collaborators who can support the new design processes.
CAD & CAM Computer aided design and Computer aided manufacturing E-Commerce	Digital systems and software Consumer facing platforms for branding & marketing Digital libraries for archiving swatches and using with software supporting knitwear and woven textile simulations	Digital system and design software- Adobe suite, Microsoft 365, TMS software, SAP, Silk, Shima Seiki Hi definition 3D scanning Simulation software	Digital supply and production management tools CAD & CAM programmes Digital libraries to support archiving and PR Routes to funding available for specialised training support
Design and product development	CAD / 3D. Prototyping.	3D. Raw materials knowledge (library import). Technical knowledge.	Virtual prototyping. 3D. Digitisation. Automation.
Design/ Prototyping	-3D simulation and footwear prototyping -3D simulation and garment prototyping	-Pattern design -3D modeling -software specialized for 3D modeling& simulation	3D Digitalization 3D virtual prototyping

7.2.3 Data acquisition

Design of production	Virtual design of garments	Application for design of materials and products	Database systems, Data collection and sorting, methods of evaluation

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	Development of platforms for waste as a material Digitisation in the monitoring of material flows Digitisation in monitoring the content of substances in waste Development of capacities, projects and platforms for the reuse of things		Visualization tools for product design and production modelling Cybersecurity – this area is important, companies see this as a barrier to wider use of digital platforms, cloud, distributed databases
Research & Development - Product Engineering	Sensor technology applied to textiles, adoption of nanotechnology	Knowledge of innovative technologies used in design, applications in different sectors (Clothing, Construction, Architecture, Medical...), electronic applications	New smart technologies: integration between textiles and electronics, RFID technologies in fibres
Production area (mainly seamstresses)	Sensors. Defect analysis. Maintenance: preventive and corrective. Open-end sewing machines (More automatic processes).	Digital basic skills. Basic machine programming and maintenance.	Basic data analysis. Basic processing information (quantitative data).

Marketing	Digital marketing, app creation for product previews, e-commerce, new business models (e.g. fashion renting)	Marketing techniques, SEO and SEM, online sales techniques (e-sales), social networks, new business models	Social media marketing, online advertising, tools and software for digital marketing (Google Ads, Google Analytics, Meta ADS, etc.).

7.2.4 Communications

Sales Department	System computer update	Specialist on sales	Electronic sales e-commerce ERP system utilization
Digital advertisements and eshops	All have stated that funding digital advertisements and holding an e-shop can be more profitable than the physical store.	A very specific comment was that e-shops have been more and more profitable, and especially during sale seasons. Moreover, the distribution of the companies' identity and products through online	Had to train staff or hire younger people for specific positions, who have knowledge of useful channels and tools.

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		platforms of sustainable based content, bring awareness to the market.	
Product advertising	Online websites	Marketing skills marketing influencer New software	Third party companies to meet expectations New collaborations with respective partners

7.3 SMART PTT

The Smart PTT areas where focus will occur relates to:

- Smart authentication methods & Radio Frequency Identification RFID technologies
- Complex composites and integrated electronics
- Innovations linked smart & intelligent textiles
- Smart sorting systems and Ai
- B2B communications and Marketing using VR & AR

7.3.1 Tools

Functional areas of the company	Technology/innovation/ Changes	Knowledge needed to perform the process	Priority Training Topics to be addressed
IT	AR/VR. AI/ML. Big data. BI. IoT.	Data science. Data engineering. Big data. AR/VR. New technologies.	Specific knowledge in textile/clothing business. On job training. Contents related with all knowledge needed (AR/VR,...).

7.3.2 Marketing

Marketing Communication	CRM / google analytics. Demographics data. Meta verse. Digital Showroom. Marketing influencer/Best practices.	Data analysis. Marketing skills / Fashion – B2C. Photo/video/digital showroom.	Choice of hardware for digital transformation & cybersecurity
Sales, communication	Blockchain – a decentralized database for tracking material and product flows	Online platforms, configurators	Online platforms, websites, configurators - all this for communication with the customer, presentation

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Customer service	Configurators, AI for modification of the product according to the customer's needs	IoT	IoT – knowledge for remote connection of text components to the Internet, control, matching of functions
Shop floor	AR/VR. AI/ML. Industrial processes. Process/product engineering.	Ability to analyse data. Operations management/optimization. Technological/textile/clothing knowledge.	Technological potentialities and barriers. Digitisation. Automation. Specific knowledge in textile/clothing business.

7.3.3 Management

Strategic management	Innovation. Strategic planning.	Innovation management. Digital literacy.	New business models. Workshops. Case studies. Good practices. Benchmark. International missions.
Design and product engineering	3D design and pattern making. Additive manufacturing Smart textiles / nanotechnology.	Design for sustainability. Digital Design and Modeling. Nanotechnology and Microelectronics. New generation artificial fibres. Monomaterials.	Design for sustainability. Modelling and 3D prototyping. Smart manufacturing. Design (technical design skills). New generation artificial fibres. Monomaterials.

Data & Traceability

Research & Development - Marketing	Data collection	Knowledge of automatic product traceability methods from supplier to consumer (weaving machines) with verifiable quality reporting, marketing techniques (creation of a product line and brand)	Traceability, Branding
Supply Chain	Certification & Traceability	Supply chain and securing buy in from all parties. In depth understanding of the consumer, their practices, digital agility and willingness to engage.	Creating QR codes Story telling and branding Farm to Yarn

7.3.4 Production

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Research & Development - Product Engineering	Sensor technology applied to textiles, adoption of nanotechnology	Knowledge of innovative technologies used in design, applications in different sectors (Clothing, Construction, Architecture, Medical...), electronic applications	New smart technologies: integration between textiles and electronics, RFID technologies in fibres
Production	New smart technologies and materials for the development of footwear for diabetics	-Pattern design; -Patient customisation; -3D pattern design and printing of personalised shoes	-3D pattern design using specialized software
PFAS chemicals, microplastics	Smart materials, Woven and nonwoven textiles, electronics, sensors	Raw materials, electronics, sensors, applications	

8. Initial and further education on advanced textiles - Areas of Existing Education & Research

The main idea of the **Greece** based YFATRONIC project was the technology development for the integration of flexible organic photovoltaic devices onto textile products (e.g. textiles for tents, clothing etc.) and the design of the appropriate electronic circuits which will support OPVs for the charging of external portable electronics devices.
The **Romanian** partners are participants in Erasmus+ Vir2Tex, aiming to use virtual reality (VR) for learning materials enhanced for distance education about textile production from fiber to clothing while the Erasmus+ CircuTex project aims to enhance the sustainability competencies of HEI students and educators in fibrous composites and technical textiles.
In **Germany** there are 16 textile Research Institutes with 1.400 researchers which provide training, ranging from basic textile knowledge to specific material and production techniques as well as management skills. Sustainable Engineering at HS Albstadt-Sigmaringen Textile and Clothing Technology, Bachelor degree course is a unique study program that addresses the issue of sustainability along the entire value chain. The combination of sustainability knowledge and engineering expertise enables a holistic view of the product development process.
Slovenia is focused on research into the use of waste material for the development of a new cellulose composite, which will be ecologically acceptable according to the principle of “Life Cycle Assessment”. Basic methods in Textile Testing’ at the University of Ljubljana, provides focused training for individuals progressing into technician roles with technical training in LEAN and ADDITIVE manufacturing and product traceability.
In the project *"SusdigiTex – Development of a digital printing process with sustainable inks for functional clothing" the* Textile Materials Technology research group at the **Swedish** School of Textiles has developed and tested a pigment ink and optimized it for single-colour prints and patterns.
Spanish HEIs facilitate training and learning in the areas of Smart Textiles (UPC and UPV) Sustainability in the textile industry (UPC) Designing sustainable textiles (UPV) Tools for Data Processing in the Textile Industry (UPV) Textile production in the industry 4.0 (UPC). ‘

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In the **Czech Republic**, Textiles is a technologically oriented programme whereas Clothing with a higher representation of design subjects is offered at several schools in the Czech Republic, it is rather artistic and craft oriented. VET professionals in the textile field are offered by several organizations such as TZÚ - Textile Testing Institute & INOTEX – a company focusing on research, development, service and technology transfer in the field of textile refinement and new technologies.
According to Eurostat, around 40% of **Portuguese** secondary school students participate in VET courses. The VET courses of the National Qualifications System lead to a double certification: a school and a professional certification. The National Qualifications Framework presents almost 30 qualifications for the textile and clothing sector, which are being reviewed in order to adapt the training offer to the current needs of the industry.
Sustainability strategies, eco-friendly products and technologies is provided through programmes in **Italy**, financed by the Piedmont Region through the European Social Fund. The patented process of Cōēo fabric by CDC (Cristina di Carlojoins) the components mechanically without chemical processes, thanks to a partnership with the Chemistry Department of the University of Pisa, the final material can be recycled again.
In **Ireland** Design for Sustainability and Circular Economies is a continued professional development (CPD) course at TUS, focusing on key areas of Life Cycle Thinking, Circular Economy Principles and Regenerative Design Practices, and in the smart space, test-beds and laboratories to expand awareness and invite collaboration in the areas of smart material and e-textile research and development are supported at the innovation lab housed in the Walton Institute.

8.1 Areas for Further Education

8.1.2 Green

- Knowledge in environmental impacts and **regulations** will be also required. Innovation linked to green and sustainable futures for the textile industry concerns **energy consumption, waste materials, fibre quality and sustaining skills.** Solutions for sustainable waste management, supply chain issues and fibre quality were also indicated as areas where innovation is required.
- The shortage of **skilled workers** in the textile industries is being felt by the companies who participated in the report. Working on the **generational transition** in textile companies is also an area which requires support going forward.
- Basic chemistry education for the current and future employees along with the necessity of understanding timings, temperature, chemical, and mechanical agitation was also indicated as areas where increased knowledge would be beneficial. It is urgent to prepare technicians with skills linked to **legislation, new technologies, eco-engineering and design for sustainability.**
- Knowledge about the **lifespan** of materials is key. Biodegradability and compostability information linked to the properties of textiles, knowledge about recycling technologies.
- Research on **sustainable raw materials**, **waste water management**, **new bio-based and bio-nylon fabrics**, new fabrics made from **deadstock and defective textiles**, new fabrics made from regenerated plastics.

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- Innovations in **sustainable finishing** and treatments.
- Basic knowledge in different fields such as, **chemistry, biology, electronics or mechanics**, will be additionally necessary for the training.
- There is a need for greener process, such as **enzymatic treatments**, recyclability and new sustainable materials. Companies stated there is a lack of knowledge among young people regarding the product and **raw material standards** and also the lack or poor knowledge of **textile terminology**. There is a need for workers to know how to use tools to implement the dictates of the circular economy in practice and not only in theory.
- Knowledge in **environmental impacts and regulations** will be also required.

8.1.3 Digital

- Companies participating in the field research and Living lab sessions said there is a lack of information and courses regarding implementing new digital solutions for sustainable production, **defect recognition, waste selection and recycling**. The industry also recognised an insufficient knowledge regarding the field of digitalisation. **Digital tools and platforms** enabling sustainability and circularity which would support Sustainability Technicians, Quality Technicians, Planning Technicians will benefit from the sector.
- Regarding the digital transition, the HEI and VET were in agreement with the challenges surrounding **data analysis and software for AI and tracking systems.**
- The education system has a substantial gap with the needs of businesses, which require skills regarding the **digitalisation of the supply chain**, technicians who know how to use **software** to make production control activities more efficient, **cyber security** management to protect production activities and sensitive data, especially new samples or new materials and client data.
- Companies are also required to have knowledge of **communication and marketing** in order to be transparent to consumers and avoid cases of green washing.
- Access to **3D Design tools** which would support designers and techicians linked to CAD pattern making tools, graphic design, technology, innovation and changes in relation to **AI, ML, AR and VR** in design and prototyping.

Smart 8.1.4

- Increased awareness and understanding of applications for **sensors and electronic circuits in e-textile materials** along with awareness of applications and users that might be impacted by the technology as it evolves. Innovation and product development assistance for specialist technicians.
- Technologies, innovations and changes linked to quality control and smart solutions for **tracking and sorting**.
- Increased access to accessible research exploring and demonstrating technical characteristics of advanced fabrics (e.g., working on the concepts of **thermal insulation, water repellence, elasticity**.
- **LCA assessment**, data gathering, automatisation supported by emerging technologies **AI and blockchain** for textile traceability and sustainability passports. Data management

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(from product and from production process). Energy efficiency and sustainability is a key area of concern.

- **Robotisation** of production lines for specific processes and the implementation of digital systems for making products (tailoring, printing). Access to modern machines that will help in the production process and consume less electricity and auxiliary energy.
- **Intelligent waste selection** and intelligent defects detection-based **video/image processing** and AI.
- **QR code and RFID technologie**s on garments with information on the production chain, fashion renting (garment rental), **NFT (Non Fungible Token**) to create **unique digital product**s, digitalise fabrics, digital marketing tools to increase the visibility of products and companies.
- There are developments being made the area of **passive smart textiles** and **bio-composites**, generated with native flax and hemp with potential applications for the automotive and aerospace industries which have the potential to embed electronics & sensors. The need exists to understand the processing requirements for a much wider range of fibre and resin systems including bio-composites, recyclable thermosets, bio-based resins, bio-based carbon fibre and **integration of electronics.**

9. Conclusions

In conclusion this report finds that there is ample opportunity to advance the industrial green, digital and smart innovations in the textile industry through innovation in learning and training.
Bold new initiatives and research in the areas of waste management and resource consumption are preparing companies for increasing regulatory compliance across the entire supply chain and therefore key focus areas for learning and training in work package 3 WP3 will focus on 5 priority training topics in each area which centre around:

1. Waste mitigation, management and recycling
2. Energy and resource consumption
3. Sustainable fibre innovations and technological advancements in fibre processing and recycling
4. LCA, Life Cycle Analysis, assessment and traceability across all critical phases and areas of operations
5. Innovations and ambitious projects linked to dying, finishing & water management

In the area of digital, priority will be given to learning and training that involve:

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1. Technologies linked to streamlining production
2. Smart sensor technologies for data acquisition
3. Tracking and authentication methods
4. Database management and cyber security
5. Design Tools and software evolution

The evolving Smart technology and textiles sector requires industry to be equipped with the knowledge and demonstrate agility in the following areas:

1. Smart authentication methods & Radio Frequency Identification RFID technologies
2. Complex composites and integrated electronics
3. Innovations linked smart & intelligent textiles
4. Smart sorting systems and Ai
5. B2B communications and Marketing using VR & AR

In line with the Green Deal and Entrepreneurship Competence Framework, these focus areas identified through the research presents opportunities for HEIs, VETs, innovation hubs and companies themselves to facilitate specialist training and support industry growth. WP3 will support this growth through knowledge transfer and skill exchange in the form of educational tools and MOOCs that up-skill existing teams through accessible platforms and that connect graduates and skilled workers with industry, encouraging co-creation between the academic and industrial textile sectors to support the resilience and sustainable GREEN, DIGITAL & SMART transition and advancement in the textile sector through innovative learning and training.

10. Summaries & insights from National results

CZECH REPUBLIC

Desk research as well as field research showed that, despite the decline of the textile industry in the past 20 years, the initial professional textile education and professional knowledge base has been preserved, both for middle-level workers and for university graduates.
Educational programs at universities correspond to the needs of companies to a better extent, but online education is very limited, currently it is only offered in partial areas of textile technology. From this point of view, there is still a significant lack of availability of knowledge for textile companies and other people interested in knowledge in the textile industry.

GERMANY

In Germany there are 9 universities where you can study highly qualified textile technology. Each of the universities has a special focus such as Textile Mechanical Engineering - Textile Manufacturing - Product Development - Smart Textiles - Innovative Textiles - Functional Textiles - Textile Electronics - Research and Development.
There is often an overlap between textile and apparel technology, which focuses on the design and production of a wide variety of textiles (e.g. outerwear). The technical part always predominates in these engineering courses.

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(…) there are 16 textile Research Institutes with 1.400 researchers which provide training, ranging from basic textile knowledge to specific material and production techniques as well as management skills. Associations, interested groups, textile cluster organisations and private educators were researched that offer training courses and workshops etc. on the topics of sustainability - digitalisation - business processes.

GREECE

(…)the advanced textiles sector is very scarce and quite unknown to the audience. Because there are not many enterprises that produce locally, there is a very sparce amount of information regarding these specialisations. Subjects as Artificial intelligence, Advanced textiles, Robotics, Augmented Reality, Metaverse, Internet of Things, etc. do not impact largely in the local industry, and if they do the impact is small.

Another major issue that was addressed in all sessions, is the poor connection between the education and the industry. One is largely disconnected from the other, even if education provides specialist training and knowledge on several green, digital and smart subjects. All education institutes insisted that the textile sector is very low in production compared to other EU countries.

ITALY

(…) textile companies are aware that important changes are ongoing and they will have to rethink their business processes and products in order not to become obsolete and non-performing for their customers. For many textile managers, the real challenge of the future will be the introduction of the textile world into the metaverse.

The research also tells us that there is a double gap. (…)the first gap is the average technological level of Italian textile companies still far from some innovations already applied in other national or other international textile industries. The second gap is created by the companies (aware of the existence of innovations in the 3 fields and know what they need to raise their technological level) and the educational system that is still anchored to classical models and timidly trying to update their educational curricula and courses.

IRELAND

A clear need for technical skill-based learning has been expressed by the industry & protected status for indigenous textiles.

An impediment to the largely wool based textile industry is the total lack of large scale wool scouring, and limited dying and finishing facilities. This impacts on the technical fibre and process knowledge in textile education.

CIRCULÉIRE Circular Fashion & Textiles Good Practice Sectoral Guide looks to shine light on the opportunities to move from the linear take-make-waste model and transition to a circular model in which Irish textiles can expand their post- production and consumer value chain. As a result of this national report, a number of the participating companies are currently trailing post-production textile recycling with a view to re-purposing the by-products of their manufacturing.

The National Smart Specialisation Strategy recognises that clustering initiatives offer a great deal of potential to act as catalysts and spark business growth where the initiatives themselves look to foster B2B and B2RD&I development and partnerships.

PORTUGAL

The Portuguese textile and clothing sector represents a significant weight in terms of employment and turnover, however, we have witnessed a decrease in the capacity to attract young talent, both by companies and by education and training promoters.

Industry is aware that this shift to the paradigm of a climate-neutral, resource-efficient, circular, digitalised and robotised economy is mandatory. However, there are difficulties in its implementation, with strong references to the cost associated with the reform of certain processes and equipment on the one hand, and the lack of in-house and market skills on the other hand.

This desk and field research shows a training offer that still does not fully respond to the needs felt by the sector for the smooth implementation of a digital, green and smart transition. The companies highlighted as essential to have training contents that reach the whole industry chain.

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ROMANIA

(…) the participants expressed a real interest in courses and collaborations in new projects aimed at the smart, digital and green transition. The company representatives specified that these investments in new technologies or human resources to produce smart, advanced materials or products must also be supported by market demands for these products. In some cases, they viewed this transition with slight scepticism, considering the insufficient financing versus the costs necessary to invest in new models and means of production.

For researchers and universities, this green-digital-smart transition is seen as a move towards generating new products, technologies, jobs and research and innovation projects.

SPAIN

The field and desk research demonstrate a compromise between European, National and regional governments towards these transitions, promoting different circular plans and funding. From the industry point of view, the situation is open to different opportunities for a field that has not shown a regression during the pandemic and it is constantly evolving. However, there is a lack of specialised employees and, due to this lack, an added energy and focus is necessary for this training.

(…) the companies are fully aware of the importance of sustainability, nowadays, in the textile sector. Therefore, they have put a lot of effort into trying to adapt their processes and products, improving constantly, and analysing its environmental impact.

The presence of smart textiles is growing up fast in the national level and, although its presence is still reduced in comparison with other technologies and products, companies are open to this transition challenges.

SLOVENIA

Research showed that the majority of Slovenian Textile companies are too small to exhibit any kind of need for implementation of programs regarding Artificial intelligence, Business Data Analytics, Augmented reality, Robotics, Meta Real software etc. However, they are implementing programs and operations in the field of green, digital and smart if they consider them useful on daily basis and if the investment costs are covered with the use of new machines/programs.

Overall Educational institutions are educating students in means of green (recycling, eco materials, close loop systems) digital (smart product design, computer programs) and smart, but are aware that not all programs and equipment they use are up to date with that industry uses on daily basis. There is a strong willingness to cooperate between students and textile companies.

SWEDEN

The transitions (green, smart and digital) are foreseen as industrial growth, however, its impact or need depends majorly upon market need and customer interest. Cost involvement at the production level and skill development play a major factor during the transition.

There is an increase in demand for the workforce at the production level in textile industries, thus it is important to increase awareness about the need and attract youth through educational and industrial promotional activities/visits.

Knowledge gap in reference to existing technology and skill development/awareness about the advanced technology in the textile industry is seen as an important need/requirement.

Partners and researchers discovered the need for a holistic approach to developing current employees' skills during these transitions.

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